

CHABOT-LAS POSITAS COMMUNITY COLLEGE DISTRICT

REQUEST FOR PROPOSAL (RFP) NO.: B25/26-11

**INSPECTOR OF RECORDS FOR THE BUILDING 1500
STEAM INC 2 & RENOVATION TO 1800 STEM
AT LAS POSITAS COLLEGE**

Bids Due:

Tuesday, May 19, 2026 at 2:00p.m.



Return Bids To:

**District Office
Purchasing & Warehouse Services Department
Attn: Marie Hampton
7600 Dublin Blvd., 3rd Floor
Dublin, CA 94568**

REQUEST FOR PROPOSAL
B25/26-11 DSA Approved Inspector of Record
For
Las Positas College Building 1500 STEAM Inc. 2 & Renovation to B1800 STEM

INTRODUCTION

The Chabot - Las Positas Community College District is soliciting from interested and qualified Consultants to provide DSA Approved Inspector of Record Services (IOR) during the construction of the **Las Positas College Building 1500 STEAM Inc. 2 & Renovation to B1800 STEM** Project.

The new STEAM and B1800 Renovation will be developed adjacent to the existing Buildings 1900 ITS, 1900A, the CUP and off the main campus boulevard at Las Positas College. The new STEAM project will have the following elements and programs. Laboratories and preparation spaces for STEAM related programs, Classrooms, Computer Labs, shared meeting rooms and workrooms. Arts, Media and Photography programs, faculty offices and shared adjunct space. The project is targeted for LEED NC v4.2 Silver Certification. The scope of work includes construction of said structures above, site and, soil stabilization, site paving, site grading, construction of site elements.

The timeline for DSA approval and estimated construction start is July 2026. The project schedule anticipates duration to be 850 calendar days from Notice to Proceed.

The DSA Inspector(s) of Record will act as the agent of the Division of State Architects at the project site and report to both the Division of the State Architect and the District's Project Planner/Manager and Construction Management consultant. The IOR will act as the agent of the District at the project site to ensure the project is constructed according to the approved DSA plans and specifications. The District's Project Planner Manager and/or Construction Manager will provide direction to the IOR.

If you are interested and qualified, please submit (1) one unbound copy of your proposal and (1) one electronic copy on thumb drive in sealed envelopes clearly marked on the outside "**Proposal B25/26-11 DSA Approved Inspector of Record - Las Positas College Building 1500 STEAM Inc. 2 & Renovation to B1800 STEM**" to the below address by **Tuesday, May 19, 2026 at 2:00p.m.**

Attn: Marie Hampton, Purchasing Manager
Chabot-Las Positas Community College
7600 Dublin Blvd, 3rd Floor
Dublin, CA 94568

Proposal questions must be submitted to Marie Hampton, Manager of Purchasing and Warehouse Services (mhampton@clpccd.org) via email before **Tuesday, May 19, 2026 by 2:00p.m.**

Proposals will be prioritized based upon experience with comparable projects in environments similar to the Las Positas College Campus.

Proposal Due Date: Tuesday, May 19, 2026 at 2:00p.m.

Proposal RFI's Due: Friday, May 8, 2026 by 2:00p.m.

Proposal Question Response Issuance: Thursday, May 14, 2026 COB.

Notice of Intent to Award: Monday, June 1, 2026

SCOPE OF CONSULTANT SERVICES

Refer to Attached Exhibit A, Draft Professional Services Agreement, and the Statement of Services, Exhibit B, which will become an exhibit to the Contract.

SUBMITTAL AND SELECTION PROCEDURE

A. SUBMITTAL REQUIREMENTS

Applicants must follow the required Proposal Format. List all proposed deliverable items, required meetings and/or critical milestones project schedule.

B. SELECTION PROCESS

The District shall review the qualifications for the Inspectors of Record Services proposed to determine his/her competency to perform the required inspection. The qualification review shall include a review of resumes with an appraisal of the candidates' education, similar project experience, project successes and may include an interview.

C. PROPOSAL FORMAT

The purpose of this proposal is to demonstrate your firm's ability to provide the required DSA- Inspector of Record Services. A major consideration will be expertise in Public Works Inspection. Consultants are urged to submit concise proposals, appropriate to the scale and duration of the Project and only include items that are relevant to this specific RFP.

A qualifying proposal must address all of the following points:

1. Project Title
2. Applicant or Firm Name
3. Firm Qualifications
 - A. Type of organization, size, professional registration, certifications, and affiliations.
 - B. Outline of recent projects completed that are directly related to the **Las Positas College Building 1500 STEAM Inc. 2 & Renovation to B1800 STEM**. Consultant is required to demonstrate specific project expertise relating to the requirements of the Project description and Scope of Services described in Exhibit A. Include examples of successes in assisting the project team in meeting construction quality, budgets, and on-time schedules.
 - C. Names, experience, qualifications and classification of each individual to conduct DSA IOR services.
 - D. Provide two (2) client references from the last 5 years, from related projects, including the name, address, and **current** phone number of the individual to contact for referral.
 - E. Any additional applicable certifications (PE, ACI, ICBO, etc.)
 - F. Current and or projected workload and availability.

4. Philosophy and Approach to Inspections

- A. Summary of philosophy and approach.
- B. Identify the specific individual who will interface with the District as single point of contact.
- C. Include resume(s) for additional Inspector of Record who will assist on project. DSA Field Inspector will determine timing.

5. Fees, Insurance, and Indemnification

A. **Fees:** Refer to Attached C, which will become an exhibit to the Contract.

- 1. Propose hourly rates and a monthly rate to perform inspection and related services, as specified under: Scope of Consultant Services, Exhibit A.
- 2. Submit an itemized fee schedule as the basis for extra services
- 3. The Consultant shall comply with Labor Code Section 1720, as amended in 1999, which requires employees engaged in certain specific work classifications be paid the prevailing wage rate found by the State of California Director of Industrial Relations.
- 4. Owner will provide at no charge a field office, desk and chair, internet connection at the jobsite. Consultant will be responsible for providing his/her own vehicle, special equipment, personal computer, printer, clerical support, and any other goods or supplies necessary to perform services as required by this contract.

B. Insurance & Indemnification:

- 1. Selected individuals or firms will be required to execute the District's Inspection Service Agreement. See Section 5 - **HOLD HARMLESS – LIABILITY AND INSURANCE** of the Draft agreement.

EXHIBIT "A"
PROFESSIONAL SERVICES AGREEMENT

THIS AGREEMENT is made and entered into this _____, in the City of Dublin, County of Alameda, State of California, by and between CHABOT-LAS POSITAS COMMUNITY COLLEGE DISTRICT, a California Community College District, (hereinafter referred to as "DISTRICT") and _____(hereinafter referred to as "CONSULTANT") having its principal place of business at _____

WITNESSETH:

WHEREAS, DISTRICT desires to engage CONSULTANT to perform certain of the professional services, and

WHEREAS, CONSULTANT represents that it is fully qualified and willing to perform the services required hereunder professional services for the "DSA Inspector of Record Services (IOR) during the construction of Chabot College Library and Learning Connection Building and,

NOW THEREFORE, for and in consideration of the covenants and conditions hereinafter set forth, the parties do mutually agree as follows:

I. **STATEMENT OF WORK**

CONSULTANT hereby agrees to perform the tasks and services set forth in Exhibit "B", entitled "Statement of Services", attached hereto and made a part hereof, in accordance with the terms and conditions, sequence, time, and manner expressed herein.

II. **COMPENSATION**

For and in consideration of the services performed by CONSULTANT hereunder, DISTRICT agrees to pay CONSULTANT the sums set forth under Attachment C – Entitled "Fee Form, IOR Services", attached hereto and made a part hereof.

III. **TERMS AND CONDITIONS**

CONSULTANT agrees to be bound by the General Provisions for Professional Services Agreement identified as Exhibit "C", also attached hereto, and made a part hereof.

IV. TERM

The Term of the Agreement shall commence as of the date set forth above and shall expire upon the Consultant's completion of the services set forth herein. The foregoing notwithstanding, the Consultant shall complete the services hereunder in a prompt manner; if the District establishes a schedule for the Consultant's completion of the services under this Agreement or portions thereof, the Consultant's completion of services under this Agreement shall comply with such schedule. The Consultant shall be liable to the District for the consequences of the Consultant's failure to complete the services under this Agreement in a prompt manner or for failure to comply with a District established schedule for completion of the services or portions thereof.

IN WITNESS WHEREOF, the authorized representatives of the parties hereto have executed this Agreement effective on the date first written above.

“DISTRICT”
CHABOT-LAS POSITAS
COMMUNITY COLLEGE DISTRICT

“CONSULTANT”

By: _____

By: _____

Print Name: _____

Print Name: _____

Title: _____

Title: _____

Date: _____

Date: _____

EXHIBIT “B”
SCOPE OF CONSULTANT SERVICES

The scope of Consultant Services included in this document is to assist individuals and firms in developing their Proposal. All submittals shall be based on, but not limited to, the services listed below. Upon successful completion of contract negotiations and issuance of a contract Notice to Proceed, the Consultant will be responsible for the following:

- A. General.** The IOR shall act as an agent for the Owner at the project site. Ensure compliance with code, plans, specifications, and quality control required of the **Las Positas College Building 1500 STEAM Inc. 2 & Renovation to B1800 STEM**
- B. Relations with the Project Team.** All inconsistencies or suspected / apparent errors in the plans and specifications shall be reported promptly to the Construction Manager and Architect for interpretation and instructions by the Architect. In no case shall the final instructions be construed to cause work to be done that is not in conformity with the approved plans, codes and regulations, specifications unless accompanying documents authorize such changes. Cooperate with the Architect, Construction Manager, Testing Lab, regulatory agencies, and appropriate governing bodies during the observation of the work of construction to ensure compliance with the approved drawings and specifications.

Request interpretations and clarifications of the approved contract drawings and specifications when necessary from the Architect via the Construction Manager.

Refer any received code interpretations that cause deviations from the approved drawings and specifications to the Architect and the Construction Manager for preparation of response. Provide required reports to the Division of State Architect. Issue correction and stop work notices and notify the Construction Manager and owner in writing if work does not conform to contract documents.

- C. Facilities and Equipment.** The Owner will provide a field office, desk and chair, and internet connection at the jobsite. Consultant will be responsible for providing his/her own vehicle, and special equipment, personal computer and related equipment, printer and any clerical support and other goods and supplies necessary to perform services as required by this contract.

D. Inspection Duties

1. General

The IOR must possess actual knowledge obtained by his or her personal inspection of the work of construction in all stages of its progress to ensure that the requirements of the approved plans and specifications are being executed.

2. Special Inspection

- a. Special Inspection by Inspectors specially approved by the District may be required on all of the following, as applicable:
1. Asphaltic concrete placement
 2. Geotechnical / soil compaction
 3. High-strength steel bolt installations
 4. Welding
 5. Electrical and Mechanical work
 6. Prefabricated modular buildings
- b. Special Inspections may be performed by the IOR if he/she has been specially approved for such

purposes. Where other Special Inspectors are required to comply with DSA and/or CBC requirements, the IOR shall manage coordination, scheduling, and provide timely reporting of results to the Construction Manager.

- c. The District may also require Special Inspection for any other shop fabrication procedures that preclude the complete inspection of the work after assembly. It may require special inspection at the site in addition to those listed above if found necessary because of the special use of a material or methods of construction.
3. **Job File.** The IOR shall keep a current and up to date file of approved plans and specifications (including all approved documents authorizing changes) on the job at all times, and shall immediately return any unapproved documents to the Construction Manager for proper action. The approved plans and specifications shall have all addenda, changes, field directives identified and posted in the job file.
 4. **Construction Procedure Records.** The IOR shall keep a record of certain phases of construction procedures including, but not limited to the following:
 - a. Concrete pouring operations. The records shall indicate time, date, and location of placing concrete and the time, date, and location of removal of forms in each portion of the structure.
 - b. Welding operations. The records shall include identification masks of welders, lists of defective welds, manner of correction of defects, etc.
 - c. All such records of construction procedures shall be kept on the job until the completion of the work. These records shall be made a part of the permanent records of the Owner.
 5. **Deviations.** The IOR shall notify the Contractor, in writing of any deviations from the approved plans and specifications that are not immediately corrected by the Contractor when brought to his or her attention. Copies of such notice shall be forwarded immediately to the Construction Manager and/or the District.

Failure on the part of the IOR to notify the Contractor of deviations from the approved plans and specifications shall in no way relieve the Contractor of any responsibilities to complete the work covered by his or her contract in accordance with the approved plans and specifications and all laws and regulations.

6. Inspect and verify that Contractor's As-Built record documents are updated on a regular basis and are complete and up to date monthly prior to processing the Contractor's monthly payment request.
7. Submit, **on a daily basis**, an activity report to the Construction Manager, including the following information as it pertains to work inspected:
 1. Activities and areas of work performed by the Contractors
 2. Manpower assigned to each Contractor and Subcontractor
 3. Equipment and materials delivered to the site.
 4. Weather conditions.
 5. Construction equipment and vehicles utilized
 6. Nature and location of the work being performed
 7. Verbal instruction and clarifications of the work given to the Contractor by the Construction Manager or Architect
 8. Inspection by representative of regulatory agencies
 9. Note occurrences or conditions that might affect Contract Sum or Contract Time
 10. List of telephone calls made of a substantial nature, including statements or commitments made during the call
 11. Record any work or material in place that does not correspond with the drawings or specifications, as well as resulting action taken. List any other problems or abnormal occurrences that arise during each

day, including notations of any particular lack of activation the pad of the Contractor. Note corrective actions taken.

12. Provide Daily photos of the project.
8. Review and monitor Contractor's construction methods and procedures during all construction activities, including earthwork, concrete placement, steel erection, all finishes, electrical, mechanical, fire alarm, etc.
9. Attend all meetings as requested in contract documents and requested by the District, such as billing meetings, specification review, coordination, progress, and pre-subcontract.
10. Assist the Construction Manager and District in scheduling all required tests and testing lab visitations required by the Contract Documents. Observe and record dates and times of all test procedures.
11. Provide copies of ALL Contractor Inspection Request's approved to the Construction Manager and maintain list of Inspections and provide at weekly meetings.
12. Inspect, verify, and document Contractor's delivered equipment and materials to ensure that they meet submittal and specification requirements. Such inspection must occur within 48 hours of Contractor's delivery to the job site.
13. Submit to the Construction Manager, in a timely manner, a detailed report or request for a clarification whenever any corrective change is necessary in field construction that will result in a variance from the drawings or specification as originally issued.
14. Assist in review the Contractor's Payment Requests at billing meetings.
15. When the Contractor's work or a designated portion thereof is substantially complete, prepare a list of incomplete or unsatisfactory items via a punch list and submit to the Construction Manager.
16. Assist in the review of Contractor's Submittals and RFI's.
17. At completion of the project, deliver all inspection records and project correspondence to the Construction Manager.
18. Prior to commencement of work, IOR will cooperate with the Construction Manager and the Architect to develop an Inspection Plan for the project.

EXHIBIT "C"
GENERAL PROVISIONS FOR
PROFESSIONAL SERVICES AGREEMENT

1. Responsibility

CONSULTANT shall be solely responsible for the professional quality, technical accuracy and the coordination of all designs, drawings, specifications, calculations, data, reports or other Services to be provided hereunder, and shall, without any additional compensation, correct or revise any errors or deficiencies promptly upon notice or discovery thereof, provided that the CONSULTANT'S obligation to correct or revise errors/discrepancies in the services provided is in addition to and not in lieu of the consultant's liability to the DISTRICT for losses, costs, expenses or damages sustained by the DISTRICT as a result of such errors/deficiencies. Neither a review, approval or acceptance of, nor payment for, any of the Services required hereunder shall be construed as a waiver of any rights under this Agreement by DISTRICT or of any cause of action arising out of the performance of this Agreement, and Subcontractor shall be liable for all damages caused by or arising out of CONSULTANT'S negligent performance of any Services provided or required hereunder.

2. Changes

DISTRICT may, upon ten (10) days written notice, make changes in the Scope of Services to be provided hereunder. If such changes result in an increase or a decrease in Services, the time required to performance thereof, or the compensation thereof, this Agreement shall be modified accordingly in writing in order for such changes to be valid.

3. Termination

A. Performance of the work and Services hereunder may be terminated by DISTRICT at any time, in whole or in part:

- (1) Whenever CONSULTANT shall default in its obligations hereunder or fails to make progress in the prosecution of the work or Services; or
- (2) For the convenience of DISTRICT.

B. Termination shall be effected by delivery to CONSULTANT of the Notice of Termination, specifying whether said termination is for default of CONSULTANT or for the convenience of DISTRICT, the extent to which performance of the work and Services is terminated; and the date upon which said termination is to become effective. If, after Notice of Termination for default, it is determined that CONSULTANT was not in default, or that CONSULTANT 's failure to fulfill its obligations was due to causes beyond its control and without its fault or negligence, the Notice of Termination shall be deemed to have been issued for the convenience of DISTRICT.

C. Following receipt of Notice of Termination, CONSULTANT shall discontinue performance on the date and to the extent specified therein, and deliver to DISTRICT the completed or partially completed plans, information, data, reports, estimates, summaries, materials, or other documents which, if performance had been completed,

would be furnished to DISTRICT. CONSULTANT shall continue performance of such part of the work and Services which are not terminated by the Notice of Termination. CONSULTANT shall prepare and submit a termination claim for services satisfactorily performed, which shall include costs and expenses, reimbursable in accordance with the Terms of this Agreement, not previously paid to CONSULTANT, incurred prior to the effective date specified in the Notice of Termination, and DISTRICT may agree upon the whole or any part of the amount(s) claimed by CONSULTANT on account of the termination or partial termination.

D. In the event of termination for default, DISTRICT shall be entitled to complete the work and Services hereunder or engage others to do so and in addition to whatever remedies it may have at law if the expense of completing said work and Services is greater than the amount CONSULTANT was to receive as compensation therefore, DISTRICT shall be entitled to recover the difference from CONSULTANT.

4. Confidentiality

CONSULTANT hereby agrees that all information provided by DISTRICT relating to the Services hereunder shall be considered confidential and proprietary, and shall not be reproduced, transmitted, used or disclosed by the CONSULTANT without the written consent of DISTRICT, except as may be necessary for the non-disclosing party to fulfill its obligations hereunder; provided that the limitation shall not apply to any information or portion thereof, which is within the public domain at the time of its disclosure. The requirements of this provision shall survive the term of this Agreement.

5. Ownership and Reuse of Documents

All non-proprietary data, information, reports, drawings, renderings, or other documents or materials prepared by CONSULTANT hereunder shall become the property of DISTRICT whether or not the work covered thereby is executed; provided that CONSULTANT may at the CONSULTANT'S cost and expense reproduce such items to retain as a record copy for its files.

6. Relationship

The legal relationship of CONSULTANT to DISTRICT hereunder shall be that of an independent contractor and not that of an agent, employee, or joint venture.

7. Examination of Records

If the Services performed by CONSULTANT hereunder are in support of any government contract or program, or under a cost reimbursable type agreement, or for any authorized additional service or reimbursable expense, Subcontractor shall until the expiration of six (6) years after final payment hereunder, maintain such books and records under generally recognized accounting methods and permit inspection by DISTRICT or any of its authorized representatives.

8. Compliance with Laws

CONSULTANT shall comply with all applicable federal, state, and local laws, ordinances, rules, regulations, and orders in effect throughout the term of this Agreement, including, but

not limited to Executive Order No. 11246 of September 24, 1965, as amended (regarding Equal Employment Opportunity), and the orders of the Secretary of Labor pursuant thereto.

9. Insurance

Prior to commencing work, the CONSULTANT shall procure and maintain at CONSULTANT'S own cost and expense for the duration of this Agreement the following insurance against claims which may arise from or in connection with the performance of the work or services hereunder by the CONSULTANT, its agents, representatives, employees or subconsultant's.

A. Minimum Limits of Insurance.

CONSULTANT shall maintain limits of no less than:

- (1) Commercial General Liability
Two Million Dollars (\$2,000,000) combined single limit per occurrence for bodily injury and property damage. Coverage shall be provided on an "occurrence" basis.
- (2) Comprehensive Automobile Liability Insurance:
One Million Dollars (\$1,000,000) combined single limit per accident for bodily injury or property damage. The following coverages shall be included:
 - (a) Owned Automobiles.
 - (b) Hired Automobiles.
 - (c) Non-Owned Automobiles.
- (3) Professional Liability Errors and Omissions Insurance: With a limit of not less than One Million Dollars (\$1,000,000).
- (4) Workers' Compensation and Employer's Liability: Workers' compensation limits as required by the Labor Code of the State of California and Employer's Liability limits of One Million Dollars (\$1,000,000) per accident.

B. Deductibles and Self-insured Retentions. Any deductibles or self-insured retentions must be declared to and approved by the DISTRICT. At the option of the DISTRICT, the insurer shall reduce or eliminate such deductibles (limited to general and automobile liability insurance only) or self-insured retentions with respect to the DISTRICT, its officials and employees, or the CONSULTANT shall procure a bond guaranteeing payment of losses and related investigation, claim administration, and defense expenses.

C. Other Insurance Provisions

- (1) General Liability and Automobile Liability Coverages Only:
 - (a) The DISTRICT, members of its boards and commissions, officers, and employees are to be covered as insureds as respects: liability arising out

of activities performed by or on behalf of the CONSULTANT; premises owned, leased, or used by the CONSULTANT; and premises on which CONSULTANT is performing services on behalf of the DISTRICT.

The coverage shall contain no special limitations on the scope of protection afforded to the DISTRICT, members of its boards and commissions, officers, and employees.

- (b) The CONSULTANT'S insurance coverage shall be primary insurance as respects the DISTRICT, members of its boards and commissions, officers, and employees. Any insurance or self-insurance maintained by the DISTRICT, its officials, and employees, shall be in excess of Consultant's insurance and shall not contribute with it.
- (c) Any failure to comply with reporting provisions of the policies shall not affect coverage provided to the DISTRICT, members of its boards and commissions, officers, or employees.
- d) Coverage shall state that CONSULTANT'S insurance shall apply separately to each insured against whom a claim is made, or suit is brought, except with respect to the limits of the insurer's liability.

(2) Workers' Compensation and Employer's Liability Coverages:

The insurer shall agree to waive all rights of subrogation against the DISTRICT, members of its boards and commissions, officers, and employees for losses arising from work performed by CONSULTANT for the DISTRICT.

(3) All Coverages.

- (a) Each insurance policy required by this Agreement shall be endorsed to state that coverage shall not be suspended, voided, canceled, or reduced in coverage limits except after thirty (30) days prior written notice has been given to the DISTRICT.
- (b) If CONSULTANT, for any reason, fails to maintain insurance coverage which is required pursuant to this Agreement, such failure shall be deemed a material breach of this Agreement. The DISTRICT, at its sole option, may terminate this Agreement in accordance with Provision Number 14, Termination. Alternatively, the DISTRICT may purchase such required insurance and may deduct that cost from sums owed to Consultant provided CONSULTANT does not obtain the insurance itself within five (5) days of receipt of the DISTRICT'S notice of intent.
- (c) CONSULTANT agrees to add designated agents of the DISTRICT as additional insured under the above policies as mutually agreed.

D. Acceptability of Insurers.

Insurance is to be placed with insurers rated A: 6 or better by A.M. Best's rating-service.

E. Verification of Coverage.

CONSULTANT shall furnish the DISTRICT with written evidence acceptable to the DISTRICT of insurance and minimum coverage amounts required by this Agreement.

F. Subconsultant's.

Prior to authorizing work by a Subconsultant to proceed, CONSULTANT shall provide to the DISTRICT evidence acceptable to the DISTRICT of insurance demonstrating satisfactory compliance by each Subconsultant with the insurance requirements stated herein.

10. Indemnity

A. To the fullest extent permitted by law, the CONSULTANT shall indemnify, defend and hold harmless the District and its employees, officers, Board of Trustee, Trustees, agents and representatives from any and all claims, demands, losses, responsibilities or liabilities for: (i) injury or death of persons; (ii) damage to property or: (iii) other costs or charges, directly or indirectly arising out of or attributable, in whole or in part, to the negligent or willful acts, omissions, errors and/or other conduct of CONSULTANT, its Design Consultants or the employees, agents and representatives of CONSULTANT or any of its Design Consultants in the performance of obligations or services or in providing work product under this Agreement. The foregoing shall include without limitation, attorneys' fees and costs incurred by the District. The provisions hereof shall apply during the period of CONSULTANT'S performance under this Agreement and shall survive the termination of this Agreement until any such claim, demand, loss, responsibility, or liability covered by the provisions hereof is barred by the applicable Statute of Limitations.

11. Remedies.

The rights and remedies set forth herein shall be in addition to any other remedies provided by law, and waiver by DISTRICT of any provision hereunder or a breach thereof by DISTRICT shall not be deemed a waiver of future compliance thereof and such provision shall continue in full force and effect.

12. Severability.

In the event that any term or provision of this Agreement is held to be illegal, invalid, or unenforceable under the laws, regulations or ordinances of any federal, state, or other government to which this Agreement is subject, such term or provision shall be deemed severed from this Agreement and the remaining terms and provisions shall remain unaffected thereby and continue in full force.

13. Notices.

All notices required or permitted under this Agreement shall be considered as duly given to any party for all purposes hereof only if given in writing and hand delivered; or sent by registered or certified mail, postage prepaid and return receipt requested; or sent by electronic email; with confirming receipt; telex, or telegram, and also confirmed by registered mail, postage prepaid and return receipt requested, addressed as set forth below, or to such other address as may be designated by notice given as provided above. All notices shall be effective upon first receipt, unless otherwise specified herein.

DISTRICT: Chabot-Las Positas Community College District
7600 Dublin Blvd, 3rd Floor
Dublin, CA, 94568
Attention: Owen Letcher
Vice Chancellor, Bond Programs and Operations
With CC to Ann Kroll
Project Planner/Manager Facilities/Bond Programs

CONSULTANT:

14. Modification.

This Agreement may only be modified by a written amendment hereto, duly executed by both parties.

15. Successors and Assignment.

CONSULTANT binds itself, its successors, assigns, and legal representatives to DISTRICT with respect to all of the covenants of this Agreement and further agrees that it shall not sell, assign, transfer, mortgage, pledge or in any manner encumber its interests in this Agreement or in any proceeds from this Agreement without the prior written consent of DISTRICT. In the event that CONSULTANT violates the foregoing prohibition, or in the event that CONSULTANT without the prior written consent of DISTRICT, which consent shall not be unreasonably withheld, sells, assigns, transfers, mortgages, pledges or in any manner encumbers, except as security for credit agreements, all or substantially all of its corporate assets, or directly or indirectly undergoes a change in control of its ownership, DISTRICT shall be entitled, at its sole option:

- A. To require the CONSULTANT'S successor to continue to perform under this Agreement and to continue to satisfactorily fulfill CONSULTANT'S obligations under this Agreement; or
- B. To terminate this Agreement. In such case CONSULTANT shall be responsible for any and all liabilities arising from such termination. In the event that DISTRICT replaces CONSULTANT with another consultant after such termination, CONSULTANT shall be responsible for any and all costs, expenses and liabilities arising from such substitution. In any event, CONSULTANT shall remain liable for any and all work product or services provided by it prior to the termination.

This Agreement and the terms hereof are binding upon and inure to the benefit of the successors and assigns of both the District and the CONSULTANT.

16. Disputes.

- A. Continuation of Consultant Services. Except in the event of the District's failure to make undisputed payment of the Contract Price due the Consultant, notwithstanding

any disputes between District and Consultant hereunder, Consultant and District shall each continue to perform their respective obligations hereunder; including the obligation of the Consultant to continue to provide and perform services hereunder pending a subsequent resolution of such disputes.

- B. Mandatory Mediation. All claims, disputes and other matters in controversy between the Consultant and the District arising out of or pertaining to this Agreement shall be submitted for resolution by non-binding mediation conducted under the auspices of the American Arbitration Association (“AAA”) and the Construction Mediation Rules of the AAA in effect at the time that a Demand For Mediation is filed. The commencement and completion of mediation proceedings pursuant to the foregoing is a condition precedent to either the District or the Consultant commencing arbitration proceedings.
- C. Binding Arbitration. Claims, disputes or other matters in question between the parties to this Agreement arising out of or relating to this Agreement or breach thereof which are not resolved through the mandatory mediation procedures set forth above shall be resolved by binding arbitration conducted in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association in effect at the time of the filing of a Demand for Arbitration, provided that the Parties may by mutual agreement modify such Rules or adopt other rules governing the conduct of arbitration proceedings.
- D. Demand for arbitration shall be filed in writing with the other party to this Agreement and with the American Arbitration Association. A demand for arbitration shall be made within a reasonable time after the claim; dispute or other matter in question has arisen. In no event shall the demand for arbitration be made after the date when institution of legal or equitable proceedings based on such claim, dispute or other matter in question would be barred by the applicable statutes of limitations.
- E. No arbitration arising out of or relating to this Agreement shall include, by consolidation, joinder or in any other manner, an additional person or entity not a party to this Agreement, except by written consent containing a specific reference to the Agreement signed by the District, CONSULTANT and any other person or entity sought to be joined. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent or with a person or entity not named or described therein. The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by the parties to this Agreement shall be specifically enforceable in accordance with applicable law in any court having jurisdiction thereof.
- F. The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

17. Extent of Agreement.
The Agreement and Exhibit A “Statement of Services,” Exhibit B “Compensation and Payment,” and Exhibit C,” General Provisions for Professional Services Agreement,” contain all of the promises, representations and understandings of the parties hereto and supersedes any previous understandings, commitments, proposals or agreements, whether oral or written, and may only be modified as hereinbefore provided.
18. Governing Laws.
Unless otherwise specified herein, this Agreement shall be governed by the law of the State of California.
19. Professional Registration.
If the CONSULTANT’s Services under this Agreement involve the production of documents or drawings that require signing or sealing by a registered professional, CONSULTANT warrants that it has such qualified person assigned to this Project who is registered in the State(s) of California.
20. Time.
Time is of the essence in the performance and completion of the CONSULTANT’S obligations under the Agreement.

END OF PAGE

ATTACHMENT A

DRUG-FREE WORKPLACE CERTIFICATION

I, _____, am the _____ of
(Print Name) (Title)
_____. I declare, state, and certify to all of the following.
(Contractor Name)

1. I am aware of the provisions and requirements of California Government Code §§8350 et seq., the Drug Free Workplace Act of 1990.
2. I am authorized to certify, and do certify, on behalf of Contractor that a drug free workplace will be provided by Contractor by doing all of the following:
 - A. Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensation, possession or use of a controlled substance is prohibited in Contractor's workplace and specifying actions which will be taken against employees for violation of the prohibition;
 - B. Establishing a drug-free awareness program to inform employees about all of the following:
 - (i) The dangers of drug abuse in the workplace;
 - (ii) Contractor's policy of maintaining a drug-free workplace;
 - (iii) The availability of drug counseling, rehabilitation, and employee-assistance programs; and
 - (iv) The penalties that may be imposed upon employees for drug abuse violations;
 - C. Requiring that each employee engaged in the performance of the Contract be given a copy of the statement required by subdivision (A), above, and that as a condition of employment by Contractor in connection with the Work of the Contract, the employee agrees to abide by the terms of the statement.
3. Contractor agrees to fulfill and discharge all of Contractor's obligations under the terms and requirements of California Government Code §8355 by, inter alia, publishing a statement notifying employees concerning: (a) the prohibition of any controlled substance in the workplace, (b) establishing a drug-free awareness program, and (c) requiring that each employee engaged in the performance of the Work of the Contract be given a copy of the statement required by California Government Code §8355(a) and requiring that the employee agree to abide by the terms of that statement.
4. Contractor and I understand that if the District determines that Contractor has either: (a) made a false certification herein, or (b) violated this certification by failing to carry out and to implement the requirements of California Government Code §§8355, the Contract awarded herein is subject to termination, suspension of payments, or both. Contractor and I further understand that, should Contractor violate the terms of the Drug-Free Workplace Act of 1990, Contractor may be subject to debarment in accordance with the provisions of California Government Code §§8350, et seq.
5. Contractor and I acknowledge that Contractor and I are aware of the provisions of California Government Code §§8350, et seq. and hereby certify that Contractor and I will adhere to, fulfill, satisfy and discharge all provisions of and obligations under the Drug-Free Workplace Act of 1990.

I declare under penalty of perjury under the laws of the State of California that all of the foregoing is true and correct.

Executed at _____ this _____ day of _____, 20____.
(City and State)

(Signature) (Handwritten or Typed Name)

ATTACHMENT B

NON-COLLUSION AFFIDAVIT

STATE OF CALIFORNIA

COUNTY OF _____

I, _____, being first duly sworn, deposes and says that I am
(Typed or Printed Name)

The _____ of _____, the party submitting
(Title) (Bidder Name)

the foregoing Bid Proposal (“the Bidder”). In connection with the foregoing Bid Proposal, the undersigned declares, states, and certifies that:

1. The Bid Proposal is not made in the interest of or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation.
2. The Bid Proposal is genuine and not collusive or sham.
3. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any other bidder or anyone else to put in sham bid, or to refrain from bidding.
4. The bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price, or that of any other bidder, or to fix any overhead, profit or cost element of the bid price or that of any other bidder, or to secure any advantage against the public body awarding the contract or of anyone interested in the proposed contract.
5. All statements contained in the Bid Proposal and related documents are true.
6. The bidder has not, directly or indirectly, submitted the bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any person, corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid.

Executed this _____ day of _____, 20__ at _____

(City, County and State)

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Signature

(Address)

Name Printed or Typed

(City, County and State)

(_____) _____
(Area Code and Telephone Number)

ATTACHMENT C

FEE FORM
IOR Services

RATES	Regular	Overtime	Weekends	Holidays
Class 1 Hourly Rate*				
Class 2 Hourly Rate*				

* Hourly rates include all costs, travel, overhead, insurance and profit.
Rates shall remain in effect for one year and are subject to change base mutual agreement.

Proposal Schedule

#	ACTIVITY ID	ACTIVITY NAME	ORIG DUR	REM'G DUR	START	FINISH	2024				2025				2026				2027				2028			
							J	J	J	S	J	J	J	S	J	J	J	S	J	J	J	S	J	J	J	S
1	LPC - STEAM Building - #46 - 12.17.25		1194	680	17-Nov-23 A	19-Sep-28																				
2	Project Award		89	0	17-Nov-23 A	01-Apr-24 A																				
3	College Calendar		903	657	23-Dec-24 A	21-Aug-28																				
4	CC - 1000	Winter Break 2024 - 2025	17	0	23-Dec-24 A	21-Jan-25 A																				
5	CC - 1010	Spring Break 2025	5	0	07-Apr-25 A	11-Apr-25 A																				
6	CC - 1020	Last Day of Spring Semester 2025	0	0		30-May-25 A																				
7	CC - 1030	First Day of Fall Semester 2025	0	0	18-Aug-25 A																					
8	CC - 1040	Winter Break 2025 - 2026	17	17	22-Dec-25*	20-Jan-26																				
9	CC - 1050	Spring Break 2026	5	5	06-Apr-26*	10-Apr-26																				
10	CC - 1060	Last Day of Spring Semester 2026	0	0		29-May-26*																				
11	CC - 1070	First Day of Fall Semester 2026	0	0	17-Aug-26*																					
12	CC - 1080	Winter Break 2026 - 2027	18	18	21-Dec-26*	19-Jan-27																				
13	CC - 1090	Spring Break 2027	5	5	05-Apr-27*	09-Apr-27																				
14	CC - 1100	Last Day of Spring Semester 2027	0	0		28-May-27*																				
15	CC - 1110	First Day of Fall Semester 2027	0	0	16-Aug-27*																					
16	CC - 1120	Winter Break 2027 - 2028	18	18	20-Dec-27*	18-Jan-28																				
17	CC - 1130	Spring Break 2028	5	5	10-Apr-28*	14-Apr-28																				
18	CC - 1140	Last Day of Spring Semester 2028	0	0		26-May-28*																				
19	CC - 1150	First Day of Fall Semester 2028	0	0	21-Aug-28*																					
20	Project Milestones		1106	680	29-Mar-24 A	19-Sep-28																				
21	Contract Milestones		1106	680	29-Mar-24 A	19-Sep-28																				
22	CM-1000	SUMMARY - PROJECT DURATION in CAL DAYS	825	680	29-Mar-24 A	19-Sep-28																				
23	CM-1010	SUMMARY - PROJECT DURATION in WORK DAYS	825	680	29-Mar-24 A	19-Sep-28																				
24	CM-1040	Notice to Proceed with Pre-Construction	0	0	29-Mar-24 A																					
25	CM-1070	GMP Approval / NTP for Inc. #1	0	0		21-Jan-25 A																				
26	CM-1060	DSA Approval - STEAM Inc.1	0	0		06-Feb-25 A																				
27	CM-1080	Start Construction	0	0	10-Feb-25 A																					
28	CM-1110	GMP Approval / NTP for B500/600 & Amplitheater Renovation	0	0	02-Jun-25 A																					
29	CM-1120	DSA Approval - B500/600 Renovation	0	0	17-Jul-25 A	17-Jul-25 A																				
30	CM-1090	DSA Approval - Amplitheater Renovation	0	0		29-Dec-25																				
31	CM-1130	GMP Approval / NTP for Inc. #2 & B1800	5	5	27-Mar-26	02-Apr-26																				
32	CM-1050	DSA Approval - STEAM Inc.2	0	0		02-Apr-26																				
33	CM-1030	Project Completion	0	0		19-Sep-28*																				
34	Construction Milestones		814	660	05-May-25 A	18-Aug-28																				
35	Inc.1 Demo/Site Prep/Make Ready		637	439	05-May-25 A	01-Dec-27																				
36	B500/B600 Renovation		110	0	10-Jul-25 A	17-Dec-25																				
37	Amplitheater Renovation		243	186	03-Oct-25 A	28-Sep-26																				
38	Inc. 2 STEAM Building		508	508	20-Apr-26	08-May-28																				
39	CMSB-1060	Start STEAM Building	0	0	20-Apr-26																					
40	CMSB-1000	Foundation Complete - Construction Milestones	0	0		26-Aug-26																				
41	CMSB-1010	Structure Complete - Construction Milestones	0	0		09-Dec-26																				



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#	ACTIVITY ID	ACTIVITY NAME	ORIG DUR	REM'G DUR	START	FINISH	2024				2025				2026				2027				2028			
							J	J	J	S	J	J	J	J	J	J	J	S	J	J	J	S	J	J	J	S
81	BIM1130	Sign-Off LOD 350 Models (Phase 1 Utility work)	0	0		05-Feb-25 A																				
82	BIM1140	Provide Sign-Off Drawings + Models to Design Team	3	0	12-Feb-25 A	21-Feb-25 A																				
83	Post-DSA Reconciliation		50	0	10-Feb-25 A	14-Mar-25 A																				
84	BIM1040	LOD 350 Trade Model Updates	5	0	10-Feb-25 A	14-Feb-25 A																				
85	BIM1050	DSA Approval+Design RFI Reconciliation Updates Coordination	10	0	10-Feb-25 A	14-Feb-25 A																				
86	BIM1090	Final Sign-Off LOD 350 Models	0	0		17-Feb-25 A																				
87	BIM1100	LOD 350 Installation+Layout Drawings Update/Submission	5	0	18-Feb-25 A	14-Mar-25 A																				
88	Amphitheater Renovation (TBD)		179	31	14-May-25 A	04-Feb-26																				
89	BIM1190	Base Scope Modeling	15	11	14-May-25 A	06-Jan-26																				
90	BIM1300	Provide Installation Drawings	5	0	14-Aug-25 A	04-Sep-25 A																				
91	BIM1240	Coordination & Model Updates	20	20	07-Jan-26	04-Feb-26																				
92	BIM1290	Sign-Off	0	0		04-Feb-26																				
93	STEAM Building		293	110	27-Feb-25 A	01-Jun-26																				
94	BIM1030	BIM Kick-Off Meeting - LOD 300 Basic & Gross Coordination	0	0	27-Feb-25 A	27-Feb-25 A																				
95	BIM1120	BIM Kick-Off Meeting - LOD 350+ Fine Coordination	0	0	21-May-25 A																					
96	Basic/Gross Coordination (Up to 100% CD)		88	0	27-Feb-25 A	25-Jul-25 A																				
97	BIM1000	Design Coordination (to 100% CD)	88	0	27-Feb-25 A	25-Jul-25 A																				
98	Fine Coordination (100% CD through DSA Appvl)		181	110	04-Aug-25 A	01-Jun-26																				
99	Underslab		78	5	04-Aug-25 A	23-Dec-25																				
100	BIM1160	Base Scope Modeling	5	0	04-Aug-25 A	08-Aug-25 A																				
101	BIM1180	Coordination & Model Updates	15	0	11-Aug-25 A	15-Sep-25 A																				
102	BIM1210	Sign-Off Underslab	0	0		06-Oct-25 A																				
103	BIM1220	Provide Sign-Off Drawings + Models to Design Team	5	5	17-Dec-25	23-Dec-25																				
104	Level 1		30	25	03-Nov-25 A	27-Jan-26																				
105	BIM1200	Base Scope Modeling	10	0	03-Nov-25 A	21-Nov-25 A																				
106	BIM1230	Coordination & Model Updates	20	15	16-Dec-25 A	12-Jan-26																				
107	BIM1260	Sign-Off Level 1	0	0		12-Jan-26																				
108	BIM1270	Provide Sign-Off Drawings + Models to Design Team	10	10	13-Jan-26	27-Jan-26																				
109	Level 2 + Roof		65	65	26-Dec-25	02-Apr-26																				
110	BIM1250	Base Scope Modeling	10	10	26-Dec-25	12-Jan-26																				
111	BIM1280	Coordination & Model Updates	45	45	13-Jan-26	19-Mar-26																				
112	BIM1330	Sign-Off Level 2 + Roof	0	0		19-Mar-26																				
113	BIM1350	Provide Sign-Off Drawings + Models to Design Team	10	10	20-Mar-26	02-Apr-26																				
114	In Wall Coordination		50	50	20-Mar-26	01-Jun-26																				
115	BIM1340	Level 1 In Wal Coordination	25	25	20-Mar-26	23-Apr-26																				
116	BIM1380	Level 1 In Wal Sign-Off	0	0		23-Apr-26																				
117	BIM1390	Level 2 In Wal Coordination	25	25	24-Apr-26	01-Jun-26																				
118	BIM1400	Level 2 In Wal Sign-Off	0	0		01-Jun-26																				
119	Post-DSA Reconciliation		35	35	02-Apr-26	20-May-26																				
120	BIM1410	Trade Model/Drawing Updates	10	10	02-Apr-26	15-Apr-26																				
121	BIM1420	DSA Approval+Design RFI Reconciliation Updates Coordination	15	15	16-Apr-26	06-May-26																				
122	BIM1430	Final Sign-Off	0	0		06-May-26																				
123	BIM1440	Installation + Fabrication Drawings Update/Submission	10	10	07-May-26	20-May-26																				
124	Building 1800 (TBD)		65	65	05-Feb-26	08-May-26																				



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Proposal Schedule

#	ACTIVITY ID	ACTIVITY NAME	ORIG DUR	REM'G DUR	START	FINISH	2024			2025			2026			2027			2028		
							J	J	S	J	J	J	J	J	S	J	J	S	J	J	S
125	BIM1310	Base Scope Modeling	30	30	05-Feb-26	20-Mar-26															
126	BIM1320	Coordination & Model Updates	30	30	23-Mar-26	01-May-26															
127	BIM1360	Sign-Off	0	0		01-May-26															
128	BIM1370	Provide Installation Drawings	5	5	04-May-26	08-May-26															
129	Pull Plan Sessions / Coordination		307	307	03-Feb-26	28-Apr-27															
130	PP-1010	Start of Construction - SOG	1	1	03-Feb-26	03-Feb-26															
131	PP-1000	SOG - Superstructure Complete	1	1	23-Jun-26	23-Jun-26															
132	PP-1050	Superstructure Complete - Building Envelope Complete	1	1	03-Sep-26	03-Sep-26															
133	PP-1040	Building Envelope Complete - Sitework & Landscape Complete	1	1	12-Oct-26	12-Oct-26															
134	PP-1020	Building Envelope Complete - Interior Finishes Complete	1	1	16-Dec-26	16-Dec-26															
135	PP-1030	Interior Finishes Complete - Commissioning Complete	1	1	28-Apr-27	28-Apr-27															
136	Submittals & Procurement		584	352	06-Jan-25 A	20-May-27															
137	Inc. 1 - Demo/Grading & Make Ready Work		234	2	06-Jan-25 A	18-Dec-25															
138	B500/B600 Renovation		157	5	20-Jan-25 A	23-Dec-25															
139	Amplitheater Renovation		174	100	02-Jun-25 A	14-May-26															
140	Inc. 2 - STEAM Building (Early Procurement)		295	295	01-Sep-25 A	02-Mar-27															
141	Electric-Traction Elevators		295	295	17-Dec-25	02-Mar-27															
142	SUBPRO-3130	Prep Equipment Submittal - Electric-Traction Elevators	60	60	17-Dec-25	19-Mar-26															
143	SUBPRO-3140	Review Equipment Submittal - Electric-Traction Elevators	20	20	20-Mar-26	16-Apr-26															
144	SUBPRO-3160	Prep Structural Attachment Submittal - Electric-Traction Elevators	15	15	17-Apr-26	07-May-26															
145	SUBPRO-3170	Review Structural Attachment Submittal - Electric-Traction Elevators	20	20	08-May-26	08-Jun-26															
146	SUBPRO-3180	Submit Structural Package to DSA - Electric-Traction Elevators	40	40	09-Jun-26	04-Aug-26															
147	SUBPRO-3150	Procure Materials - Electric-Traction Elevators	140	140	05-Aug-26	02-Mar-27															
148	Aluminum-Framed Entrances & Storefronts		290	290	17-Dec-25	23-Feb-27															
149	SUBPRO-1300	Prep Submittal - Aluminum-Framed Entrances & Storefronts	20	20	17-Dec-25	20-Jan-26															
150	SUBPRO-2200	Review Submittal - Aluminum-Framed Entrances & Storefronts	20	20	21-Jan-26	19-Feb-26															
151	SUBPRO-2220	Develop Structural Submittal	15	15	20-Feb-26	12-Mar-26															
152	SUBPRO-2230	DSA Review Deferred Submittal	30	30	16-Apr-26	29-May-26															
153	SUBPRO-2570	Procure Materials from Manufacturer - Aluminum-Framed Entrances & Storefronts	80	80	02-Jun-26	24-Sep-26															
154	SUBPRO-2590	Fabricate Aluminum Entrances - Aluminum-Framed Entrances & Storefronts	100	100	25-Sep-26	23-Feb-27															
155	Power System Study		30	30	17-Dec-25	03-Feb-26															
156	SUBPRO-1040	Prep Submittal - Power System Study	15	15	17-Dec-25	12-Jan-26															
157	SUBPRO-2190	Review Submittal - Power System Study	15	15	13-Jan-26	03-Feb-26															
158	Switchboards & Panelboards		240	240	01-Sep-25 A	07-Dec-26															
159	SUBPRO-4070	Prep Submittal - Switchboards & Panelboards	80	0	01-Sep-25 A	16-Oct-26 A															
160	SUBPRO-4080	Review Submittal - Switchboards & Panelboards	20	0	20-Oct-25 A	01-Dec-25 A															
161	SUBPRO-4090	Procure Materials - Switchboards & Panelboards	240	240	17-Dec-25	07-Dec-26															
162	Dry Type Transformers		105	100	01-Sep-25 A	08-Jun-26															
163	SUBPRO-4040	Prep Submittal - Dry Type Transformers	40	0	01-Sep-25 A	16-Oct-25 A															
164	SUBPRO-4050	Review Submittal - Dry Type Transformers	20	0	20-Oct-25 A	01-Dec-25 A															
165	SUBPRO-4060	Procure Materials - Dry Type Transformers	100	100	13-Jan-26	08-Jun-26															
166	Interior Lighting		200	200	17-Dec-25	08-Oct-26															
167	SUBPRO-1130	Prep Submittal - Interior Lighting	60	60	17-Dec-25	19-Mar-26															

Proposal Schedule

#	ACTIVITY ID	ACTIVITY NAME	ORIG DUR	REM'G DUR	START	FINISH	2024				2025				2026				2027				2028			
							J	J	J	S	J	J	J	J	J	J	J	S	J	J	J	S	J	J	J	S
168	SUBPRO-1750	Review Submittal - Interior Lighting	40	40	20-Mar-26	14-May-26																				
169	SUBPRO-2100	Procure Materials - Interior Lighting	100	100	15-May-26	08-Oct-26																				
170	Exterior Lighting		220	220	17-Dec-25	05-Nov-26																				
171	SUBPRO-1120	Prep Submittal - Exterior Lighting	60	60	17-Dec-25	19-Mar-26																				
172	SUBPRO-1740	Review Submittal - Exterior Lighting	40	40	20-Mar-26	14-May-26																				
173	SUBPRO-2090	Procure Materials - Exterior Lighting	120	120	15-May-26	05-Nov-26																				
174	Inc. 2 - STEAM Building		352	352	17-Dec-25	20-May-27																				
175	Cast-In-Place Concrete		25	25	17-Apr-26	21-May-26																				
176	SUBPRO-3250	Prep Submittal - Concrete	10	10	17-Apr-26	30-Apr-26																				
177	SUBPRO-3280	Review Submittal - Concrete	10	10	24-Apr-26	07-May-26																				
178	SUBPRO-3260	Procure Materials - Concrete	10	10	08-May-26	21-May-26																				
179	Reinforcement		45	45	03-Apr-26	08-Jun-26																				
180	SUBPRO-1050	Prep Submittal - Reinforcement	10	10	03-Apr-26	16-Apr-26																				
181	SUBPRO-1670	Review Submittal - Reinforcement	15	15	17-Apr-26	07-May-26																				
182	SUBPRO-1850	Procure Reinforcement - Reinforcement	20	20	08-May-26	08-Jun-26																				
183	Anchor Bolt Drawings		25	25	05-Mar-26	08-Apr-26																				
184	SUBPRO-1080	Prep Submittal - Anchor Bolt Drawings	20	20	05-Mar-26	01-Apr-26																				
185	SUBPRO-1700	Review Submittal - Anchor Bolt Drawings	10	10	12-Mar-26	25-Mar-26																				
186	SUBPRO-1870	Procure Anchor Bolts - Anchor Bolt Drawings	10	10	26-Mar-26	08-Apr-26																				
187	Structural Steel Framing		170	170	17-Dec-25	25-Aug-26																				
188	SUBPRO-1090	Prep Submittal - Structural Steel	80	80	17-Dec-25	16-Apr-26																				
189	SUBPRO-1720	Review Submittal - Structural Steel	20	20	17-Apr-26	14-May-26																				
190	SUBPRO-2070	Procure & Fabricate Structural Steel Framing - Structural Steel	70	70	15-May-26	25-Aug-26																				
191	Steel Decking		100	100	17-Apr-26	10-Sep-26																				
192	SUBPRO-2830	Prep Steel Decking Submittal - Steel Decking	40	40	17-Apr-26	15-Jun-26																				
193	SUBPRO-2840	Review Steel Decking Submittal - Steel Decking	20	20	16-Jun-26	14-Jul-26																				
194	SUBPRO-2850	Procure Steel Materials - Steel Decking	40	40	15-Jul-26	10-Sep-26																				
195	Metal Pan Stairs		160	160	17-Apr-26	07-Dec-26																				
196	SUBPRO-3320	Prep Submittal - Metal Pan Stairs	80	80	17-Apr-26	11-Aug-26																				
197	SUBPRO-3330	Review Submittal - Metal Pan Stairs	20	20	12-Aug-26	10-Sep-26																				
198	SUBPRO-3340	Procure Materials - Metal Pan Stairs	60	60	11-Sep-26	07-Dec-26																				
199	Architectural Woodwork		235	235	02-Jun-26	11-May-27																				
200	SUBPRO-1230	Prep Submittal - Architectural Woodwork	180	180	02-Jun-26	23-Feb-27																				
201	SUBPRO-1790	Review Submittal - Architectural Woodwork	20	20	24-Feb-27	23-Mar-27																				
202	SUBPRO-2140	Field Dimension Casework - Architectural Woodwork	5	5	24-Mar-27	30-Mar-27																				
203	SUBPRO-2130	Procure Materials - Architectural Woodwork	30	30	31-Mar-27	11-May-27																				
204	Pre Fab Metal Stud Walls		352	352	17-Dec-25	20-May-27																				
205	SUBPRO-1270	Prep Submittal - Metal Wall Panels	50	50	17-Dec-25	05-Mar-26																				
206	SUBPRO-1900	Review Submittal - Metal Wall Panels	20	20	06-Mar-26	02-Apr-26																				
207	SUBPRO-2380	Field Dimension - Metal Wall Panels	5	5	03-Feb-27	09-Feb-27																				
208	SUBPRO-2320	Procure Materials - Metal Wall Panels	70	70	10-Feb-27	20-May-27																				
209	Single Ply Roofing System		150	150	02-Jun-26	07-Jan-27																				
210	SUBPRO-2890	Prep Submittal - Thermoplastic-Polyolefin Roofing	100	100	02-Jun-26	22-Oct-26																				
211	SUBPRO-2900	Review Submittal - Thermoplastic-Polyolefin Roofing	20	20	23-Oct-26	19-Nov-26																				



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Proposal Schedule

#	ACTIVITY ID	ACTIVITY NAME	ORIG DUR	REM'G DUR	START	FINISH	2024					2025					2026					2027					2028					
							J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	
212	SUBPRO-2910	Procure Materials - Thermoplastic-Polyolefin Roofing	30	30	20-Nov-26	07-Jan-27																										
213	Hollow Metal Doors & Frames		150	150	01-Jun-26	06-Jan-27																										
214	SUBPRO-1110	Prep Submittal - Hollow Metal Frames & Doors	60	60	01-Jun-26	24-Aug-26																										
215	SUBPRO-1730	Review Submittal - Hollow Metal Frames & Doors	30	30	25-Aug-26	07-Oct-26																										
216	SUBPRO-2080	Procure Materials - Hollow Metal Frames & Doors	60	60	08-Oct-26	06-Jan-27																										
217	Door Hardware		140	140	02-Jun-26	21-Dec-26																										
218	SUBPRO-1310	Prep Submittal - Door Hardware	60	60	02-Jun-26	25-Aug-26																										
219	SUBPRO-1920	Review Submittal - Door Hardware	40	40	26-Aug-26	22-Oct-26																										
220	SUBPRO-2340	Procure Materials - Door Hardware	40	40	23-Oct-26	21-Dec-26																										
221	Fire Suppression		110	110	21-May-26	28-Oct-26																										
222	SUBPRO-1440	Prep Submittal - Fire Suppression	60	60	21-May-26	17-Aug-26																										
223	SUBPRO-1990	Review Submittal - Fire Suppression	20	20	18-Aug-26	16-Sep-26																										
224	SUBPRO-2780	Procure Materials - Fire Suppression	30	30	17-Sep-26	28-Oct-26																										
225	Air Handling Units		140	140	17-Dec-25	14-Jul-26																										
226	SUBPRO-3890	Prep Submittal - Indoor Air Handling Units	50	50	17-Dec-25	05-Mar-26																										
227	SUBPRO-3900	Review Submittal - Indoor Air Handling Units	20	20	06-Mar-26	02-Apr-26																										
228	SUBPRO-3910	Procure Materials - Indoor Air Handling Units	70	70	03-Apr-26	14-Jul-26																										
229	Fire Alarm System		140	140	02-Jun-26	21-Dec-26																										
230	SUBPRO-1190	Prep Submittal - Fire Alarm System	80	80	02-Jun-26	24-Sep-26																										
231	SUBPRO-2510	Review Submittal - Fire Alarm System	20	20	25-Sep-26	22-Oct-26																										
232	SUBPRO-2810	Procure Materials - Fire Alarm System	40	40	23-Oct-26	21-Dec-26																										
233	Construction		871	656	02-Dec-24 A	14-Aug-28																										
234	Mock-Ups		91	91	17-Dec-25	01-May-26																										
235	Building Envelope		91	91	17-Dec-25	01-May-26																										
236	MU-2000	Develop Mock-Up Drawing for Exterior Finishes	30	30	17-Dec-25	03-Feb-26																										
237	MU-2010	Procure Mock-Up Materials for Exterior Finishes	30	30	04-Feb-26	19-Mar-26																										
238	MU-2040	Pour Foundation for Exterior Finish Mock-Up	2	2	20-Mar-26	23-Mar-26																										
239	MU-2050	Frame & Sheath Mock-Up	3	3	24-Mar-26	26-Mar-26																										
240	MU-2060	Install Air Barrier	1	1	27-Mar-26	27-Mar-26																										
241	MU-2070	Install Plaster System	10	10	30-Mar-26	10-Apr-26																										
242	MU-2080	Install Exterior Insulation & Wall Furring Strips	1	1	13-Apr-26	13-Apr-26																										
243	MU-2100	Install Metal Wall Panels	1	1	14-Apr-26	14-Apr-26																										
244	MU-2110	Install Glazing System	1	1	15-Apr-26	15-Apr-26																										
245	MU-2120	Place All Exterior Sealants	1	1	16-Apr-26	16-Apr-26																										
246	MU-2240	Review & Approve Finishes	5	5	17-Apr-26	23-Apr-26																										
247	MU-2130	Perform Water Test	1	1	01-May-26	01-May-26																										
248	Inc. 1 - Demo/Grading & Make Ready Work		264	20	02-Dec-24 A	04-Mar-26																										
249	B500/B600 Renovations		152	25	16-Jun-25 A	27-Jan-26																										
250	Amplitheather Renovation		160	135	01-Oct-25 A	07-Jul-26																										
251	Inc. 2 - STEAM Building		384	384	16-Apr-26	01-Nov-27																										
252	Footings & Slab on Grade		132	132	16-Apr-26	23-Oct-26																										
253	F SOG-1000	Survey Building Grid Lines	2	2	16-Apr-26	17-Apr-26																										



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#	ACTIVITY ID	ACTIVITY NAME	ORIG DUR	REM'G DUR	START	FINISH	2024				2025				2026				2027				2028											
							J	J	J	S	J	J	J	S	J	J	J	S	J	J	J	S	J	J	J	S								
254	FSOG-1020	Layout & Excavate Foundations	20	20	20-Apr-26	15-May-26																												
255	FSOG-1010	Excavate Elevator Pit	5	5	11-May-26	15-May-26																												
256	FSOG-1060	Install Foundation Reinforcement & Anchor Bolts	20	20	15-May-26	15-Jun-26																												
257	FSOG-1050	Place Concrete for Foundations	10	10	09-Jun-26	22-Jun-26																												
258	FSOG-1030	Form, Rebar & Concrete for Elevator Pit Slab	6	6	09-Jun-26	16-Jun-26																												
259	FSOG-1040	Form, Rebar & Place Concrete for Elevator Pit Walls	10	10	17-Jun-26	30-Jun-26																												
260	FSOG-1070	Form Slab Edge & Blockouts	10	10	01-Jul-26	15-Jul-26																												
261	FSOG-1080	Place Waterproofing & Backfill Around Elevator Pit Walls	7	7	07-Jul-26	15-Jul-26																												
262	FSOG-1090	Place Rock & Vapor Barrier for Slab on Grade	5	5	29-Jul-26	04-Aug-26																												
263	FSOG-1100	Place Slab on Grade Reinforcement	10	10	10-Aug-26	21-Aug-26																												
264	FSOG-1130	Install Entrance Mat Frames	2	2	20-Aug-26	21-Aug-26																												
265	FSOG-1110	Place Slab on Grade Concrete	3	3	24-Aug-26	26-Aug-26																												
266	FSOG-1120	Strip & Clean Slab on Grade	5	5	27-Aug-26	02-Sep-26																												
267	FSOG-1140	Grout Base Plates	7	7	12-Oct-26	20-Oct-26																												
268	FSOG-1150	Place Concrete for Brace Frame & Column Blockouts	3	3	21-Oct-26	23-Oct-26																												
269	Underslab Utilities		77	77	20-Apr-26	07-Aug-26																												
270	UU-1000	Install Utility Sleeves Through Perimeter Foundations	10	10	20-Apr-26	01-May-26																												
271	UU-1010	Install Underslab Electrical Secondary	7	7	23-Jun-26	01-Jul-26																												
272	UU-1020	Install Sanitary Sewer Waste Lines	15	15	24-Jun-26	15-Jul-26																												
273	UU-1030	Install Fire Riser	3	3	02-Jul-26	07-Jul-26																												
274	UU-1040	Install Underslab Low Voltage Conduit	7	7	02-Jul-26	13-Jul-26																												
275	UU-1035	Install Domestic Water Service Underslab	7	7	20-Jul-26	28-Jul-26																												
276	UU-1050	Install Storm Drain Underslab	5	5	20-Jul-26	24-Jul-26																												
277	UU-1060	Install Shallow Domestic Water Underslab & Floor Sinks	3	3	05-Aug-26	07-Aug-26																												
278	Superstructure		89	89	03-Sep-26	14-Jan-27																												
279	SUP-1000	Erect Structural Steel	25	25	03-Sep-26	09-Oct-26																												
280	SUP-1010	Place 2nd Floor Deck	2	2	14-Sep-26	15-Sep-26																												
281	SUP-1030	Place Roof Deck	2	2	28-Sep-26	29-Sep-26																												
282	SUP-1100	Spread & Weld 2nd Floor Decking	15	15	05-Oct-26	23-Oct-26																												
283	SUP-1050	Plumb & Line Structure	5	5	05-Oct-26	09-Oct-26																												
284	SUP-1060	Install 2nd Floor Temporary Guardrails	5	5	05-Oct-26	09-Oct-26																												
285	SUP-1045	Install Elevator Guiderail Supports	5	5	12-Oct-26	16-Oct-26																												
286	SUP-1070	Install Roof Temporary Guardrails	5	5	12-Oct-26	16-Oct-26																												
287	SUP-1080	Weld Structural Steel Level 1	10	10	12-Oct-26	23-Oct-26																												
288	SUP-1110	Spread & Weld Roof Decking	15	15	26-Oct-26	13-Nov-26																												
289	SUP-1090	Weld Structural Steel Level 2	10	10	26-Oct-26	06-Nov-26																												
290	SUP-1120	Layout & Install Sleeves & Inserts for 2nd Floor Deck	5	5	11-Nov-26	17-Nov-26																												
291	SUP-1200	Layout & Install Sleeves & Inserts for 3rd Floor Deck	5	5	16-Nov-26	20-Nov-26																												
292	SUP-1145	Place 2nd Floor Reinforcement	5	5	18-Nov-26	24-Nov-26																												
293	SUP-1220	Place Roof Reinforcement	5	5	19-Nov-26	25-Nov-26																												
294	SUP-1150	Place Concrete for 2nd Floor Deck	3	3	25-Nov-26	01-Dec-26																												
295	SUP-1230	Place Concrete for Roof Deck	3	3	30-Nov-26	02-Dec-26																												
296	SUP-1170	Place Housekeeping Pads	5	5	03-Dec-26	09-Dec-26																												
297	SUP-1130	Erect Stairs	25	25	08-Dec-26	14-Jan-27																												



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#	ACTIVITY ID	ACTIVITY NAME	ORIG DUR	REM'G DUR	START	FINISH	2024				2025				2026				2027				2028														
							J	J	J	S	J	J	J	J	J	J	J	S	J	J	J	S	J	J	J	S	J	J	J	S							
342	L1-RI-1080	Frame Interior Walls	25	25	15-Jan-27	23-Feb-27																															<input type="checkbox"/> Frame Interior Walls
343	L1-RI-1110	Fire Alarm Rough In	10	10	26-Jan-27	08-Feb-27																													<input type="checkbox"/> Fire Alarm Rough In		
344	L1-RI-1120	Rough In for HVAC Piping	10	10	26-Jan-27	08-Feb-27																													<input type="checkbox"/> Rough In for HVAC Piping		
345	L1-RI-1130	Rough In for HVAC Branch Duct	10	10	26-Jan-27	08-Feb-27																													<input type="checkbox"/> Rough In for HVAC Branch Duct		
346	L1-RI-1140	Electrical Rough In In-Wall	15	15	26-Jan-27	15-Feb-27																													<input type="checkbox"/> Electrical Rough In In-Wall		
347	L1-RI-1150	Frame Hardlids	10	10	24-Feb-27	09-Mar-27																													<input type="checkbox"/> Frame Hardlids		
348	L1-RI-1160	Frame & Sheath Elevator Shaft	10	10	24-Feb-27	09-Mar-27																													<input type="checkbox"/> Frame & Sheath Elevator Shaft		
349	L1-RI-1170	Duct Insulation	5	5	02-Mar-27	08-Mar-27																													<input type="checkbox"/> Duct Insulation		
350	L1-RI-1180	Piping & Duct Identification	3	3	09-Mar-27	11-Mar-27																													<input type="checkbox"/> Piping & Duct Identification		
351	L1-RI-1190	Hang Drywall One Side	15	15	24-Mar-27	13-Apr-27																													<input type="checkbox"/> Hang Drywall One Side		
352	L1-RI-1200	Set and Anchor Switchgear	5	5	24-Mar-27	30-Mar-27																													<input type="checkbox"/> Set and Anchor Switchgear		
353	L1-RI-1210	Pull In, Test & Make Up Electrical Feeders	10	10	31-Mar-27	13-Apr-27																													<input type="checkbox"/> Pull In, Test & Make Up Electrical Feeders		
354	L1-RI-1220	Insulation @ Walls	5	5	07-Apr-27	13-Apr-27																													<input type="checkbox"/> Insulation @ Walls		
355	L1-RI-1230	Hang Drywall Second Side	15	15	14-Apr-27	04-May-27																													<input type="checkbox"/> Hang Drywall Second Side		
356	L1-RI-1250	Install Elevator Guid rails	10	10	14-Apr-27	27-Apr-27																													<input type="checkbox"/> Install Elevator Guid rails		
357	L1-RI-1240	Tape & Top Drywall	20	20	28-Apr-27	27-May-27																													<input type="checkbox"/> Tape & Top Drywall		
358	L1-RI-1260	Install Elevator Platform	10	10	28-Apr-27	11-May-27																													<input type="checkbox"/> Install Elevator Platform		
359	L1-RI-1280	Install Elevator Cab	20	20	12-May-27	10-Jun-27																													<input type="checkbox"/> Install Elevator Cab		
360	L1-RI-1270	Install Elevator Fronts	6	6	11-Jun-27	18-Jun-27																													<input type="checkbox"/> Install Elevator Fronts		
361	Finish Interior		113	113	14-Apr-27	27-Sep-27																													27-Sep-27, Finish Interior		
362	L1-FI-1000	Install Cable Tray	10	10	14-Apr-27	27-Apr-27																													<input type="checkbox"/> Install Cable Tray		
363	L1-FI-1010	Pull & Make Up Branch Wire	15	15	05-May-27	27-May-27																													<input type="checkbox"/> Pull & Make Up Branch Wire		
364	L1-FI-1020	Install Low Voltage Cabling	20	20	05-May-27	03-Jun-27																													<input type="checkbox"/> Install Low Voltage Cabling		
365	L1-FI-1030	Electrical Panel Make Up & Terminations	15	15	19-May-27	10-Jun-27																													<input type="checkbox"/> Electrical Panel Make Up & Terminations		
366	L1-FI-1040	Painting	10	10	28-May-27	10-Jun-27																													<input type="checkbox"/> Painting		
367	L1-FI-1050	Install Tile in Restrooms	15	15	03-Jun-27	23-Jun-27																													<input type="checkbox"/> Install Tile in Restrooms		
368	L1-FI-1070	T - Bar Grid	15	15	11-Jun-27	01-Jul-27																													<input type="checkbox"/> T - Bar Grid		
369	L1-FI-1080	Fire Einguishers & Cabinets	2	2	11-Jun-27	14-Jun-27																													<input type="checkbox"/> Fire Einguishers & Cabinets		
370	L1-FI-1090	Install Acoustical Panels	5	5	11-Jun-27	17-Jun-27																													<input type="checkbox"/> Install Acoustical Panels		
371	L1-FI-1100	Install Casework	10	10	11-Jun-27	24-Jun-27																													<input type="checkbox"/> Install Casework		
372	L1-FI-1110	Install FRP	2	2	11-Jun-27	14-Jun-27																													<input type="checkbox"/> Install FRP		
373	L1-FI-1120	Install Projection Screens	10	10	11-Jun-27	24-Jun-27																													<input type="checkbox"/> Install Projection Screens		
374	L1-FI-1130	Install Roller Shades	10	10	11-Jun-27	24-Jun-27																													<input type="checkbox"/> Install Roller Shades		
375	L1-FI-1140	Install Light Fixtures & Electrical Trim	10	10	15-Jun-27	28-Jun-27																													<input type="checkbox"/> Install Light Fixtures & Electrical Trim		
376	L1-FI-1150	Install HVAC Grills & Diffusers	10	10	18-Jun-27	01-Jul-27																													<input type="checkbox"/> Install HVAC Grills & Diffusers		
377	L1-FI-1160	Install All Low Voltage Devices	10	10	18-Jun-27	01-Jul-27																													<input type="checkbox"/> Install All Low Voltage Devices		
378	L1-FI-1060	Install Elevator Door Smoke Containment System	6	6	21-Jun-27	28-Jun-27																													<input type="checkbox"/> Install Elevator Door Smoke Con		
379	L1-FI-1170	Adjust Fire Sprinkler Drops	7	7	23-Jun-27	01-Jul-27																													<input type="checkbox"/> Adjust Fire Sprinkler Drops		
380	L1-FI-1190	Install Countertops	3	3	06-Jul-27	08-Jul-27																													<input type="checkbox"/> Install Countertops		
381	L1-FI-1210	Install Visual Display Surfaces	5	5	06-Jul-27	12-Jul-27																													<input type="checkbox"/> Install Visual Display Surfaces		
382	L1-FI-1220	Install Plumbing Finish	10	10	09-Jul-27	22-Jul-27																													<input type="checkbox"/> Install Plumbing Finish		
383	L1-FI-1180	Install Ceiling Tile	10	10	27-Jul-27	09-Aug-27																													<input type="checkbox"/> Install Ceiling Tile		
384	L1-FI-1200	Install Perforated Ceiling Panels	5	5	27-Jul-27	02-Aug-27																													<input type="checkbox"/> Install Perforated Ceiling Panels		
385	L1-FI-1250	Signage	2	2	10-Aug-27	11-Aug-27																													<input type="checkbox"/> Signage		



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#	ACTIVITY ID	ACTIVITY NAME	ORIG DUR	REM'G DUR	START	FINISH	2024			2025			2026			2027			2028			
							J	J	S	J	J	J	J	J	S	J	J	S	J	J	S	
386	L1-FI-1230	Install Toilet Partitions & Accessories	5	5	07-Sep-27	13-Sep-27																Install Toilet Partitions & Accessories
387	L1-FI-1240	Install Floor Coverings	10	10	14-Sep-27	27-Sep-27																Install Floor Coverings
388	L1-FI-1260	Install Doors & Hardware	10	10	14-Sep-27	27-Sep-27																Install Doors & Hardware
389	2nd Floor		185	185	16-Dec-26	16-Sep-27																16-Sep-27, 2nd Floor
390	Rough Interior		134	134	16-Dec-26	01-Jul-27																01-Jul-27, Rough Interior
391	L2-RI-1000	Install Framing Clips Prior to Fireproofing	10	10	16-Dec-26	31-Dec-26																Install Framing Clips Prior to Fireproofing
392	L2-RI-1010	Install MEPF Hangers Prior to Fireproofing	10	10	16-Dec-26	31-Dec-26																Install MEPF Hangers Prior to Fireproofing
393	L2-RI-1020	Cementitious Fireproofing	10	10	04-Jan-27	15-Jan-27																Cementitious Fireproofing
394	L2-RI-1030	Rough In Primary Duct	15	15	19-Jan-27	08-Feb-27																Rough In Primary Duct
395	L2-RI-1040	Fire Spinkler Rough In	15	15	19-Jan-27	08-Feb-27																Fire Spinkler Rough In
396	L2-RI-1050	Plumbing Rough In	20	20	26-Jan-27	24-Feb-27																Plumbing Rough In
397	L2-RI-1060	Electrical Rough In Above Ceiling	20	20	26-Jan-27	24-Feb-27																Electrical Rough In Above Ceiling
398	L2-RI-1070	Set Door Frames	1	1	28-Jan-27	28-Jan-27																Set Door Frames
399	L2-RI-1080	Frame Interior Walls	25	25	28-Jan-27	05-Mar-27																Frame Interior Walls
400	L2-RI-1090	Hang Interference Wall Drywall	5	5	02-Feb-27	08-Feb-27																Hang Interference Wall Drywall
401	L2-RI-1110	Fire Alarm Rough In	10	10	25-Feb-27	10-Mar-27																Fire Alarm Rough In
402	L2-RI-1140	Electrical Rough In In-Wall	15	15	25-Feb-27	17-Mar-27																Electrical Rough In In-Wall
403	L2-RI-1150	Frame Hardlids	10	10	08-Mar-27	19-Mar-27																Frame Hardlids
404	L2-RI-1160	Frame & Sheath Elevator Shaft	10	10	08-Mar-27	19-Mar-27																Frame & Sheath Elevator Shaft
405	L2-RI-1100	Set VAVs	10	10	08-Mar-27	19-Mar-27																Set VAVs
406	L2-RI-1120	Rough In for HVAC Piping	10	10	22-Mar-27	02-Apr-27																Rough In for HVAC Piping
407	L2-RI-1130	Rough In for HVAC Branch Duct	10	10	22-Mar-27	02-Apr-27																Rough In for HVAC Branch Duct
408	L2-RI-1170	Duct Insulation	5	5	05-Apr-27	09-Apr-27																Duct Insulation
409	L2-RI-1180	Piping & Duct Identification	3	3	12-Apr-27	14-Apr-27																Piping & Duct Identification
410	L2-RI-1190	Hang Drywall One Side	15	15	05-May-27	27-May-27																Hang Drywall One Side
411	L2-RI-1200	Insulation @ Walls	5	5	19-May-27	27-May-27																Insulation @ Walls
412	L2-RI-1210	Hang Drywall Second Side	15	15	28-May-27	17-Jun-27																Hang Drywall Second Side
413	L2-RI-1220	Tape & Top Drywall	20	20	04-Jun-27	01-Jul-27																Tape & Top Drywall
414	L2-RI-1230	Install Elevator Fronts	6	6	18-Jun-27	25-Jun-27																Install Elevator Fronts
415	Finish Interior		76	76	28-May-27	16-Sep-27																16-Sep-27, Finish Interior
416	L2-FI-1000	Pull & Make Up Branch Wire	15	15	28-May-27	17-Jun-27																Pull & Make Up Branch Wire
417	L2-FI-1010	Install Cable Tray	10	10	28-May-27	10-Jun-27																Install Cable Tray
418	L2-FI-1020	Install Low Voltage Cabling	20	20	11-Jun-27	12-Jul-27																Install Low Voltage Cabling
419	L2-FI-1030	Electrical Panel Make Up & Terminations	15	15	18-Jun-27	12-Jul-27																Electrical Panel Make Up & Terminations
420	L2-FI-1040	Install Elevator Door Smoke Containment System	6	6	28-Jun-27	07-Jul-27																Install Elevator Door Smoke Containment System
421	L2-FI-1050	Painting	10	10	06-Jul-27	19-Jul-27																Painting
422	L2-FI-1060	Install Tile in Restrooms	15	15	12-Jul-27	30-Jul-27																Install Tile in Restrooms
423	L2-FI-1070	Fire Einguishers & Cabinets	2	2	20-Jul-27	21-Jul-27																Fire Einguishers & Cabinets
424	L2-FI-1080	Install Acoustical Panels	5	5	20-Jul-27	26-Jul-27																Install Acoustical Panels
425	L2-FI-1090	Install Casework	10	10	20-Jul-27	02-Aug-27																Install Casework
426	L2-FI-1100	Install FRP	2	2	20-Jul-27	21-Jul-27																Install FRP
427	L2-FI-1110	T - Bar Grid	15	15	21-Jul-27	10-Aug-27																T - Bar Grid
428	L2-FI-1120	Install Projection Screens	10	10	21-Jul-27	03-Aug-27																Install Projection Screens
429	L2-FI-1130	Install Roller Shades	10	10	21-Jul-27	03-Aug-27																Install Roller Shades



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							J	J	J	S	J	J	J	S	J	J	J	S	J	J	J	S	J	J	J	S
430	L2-FI-1140	Install Light Fixtures & Electrical Trim	10	10	23-Jul-27	05-Aug-27																				
431	L2-FI-1150	Install HVAC Grills & Diffusers	10	10	23-Jul-27	05-Aug-27																				
432	L2-FI-1160	Install All Low Voltage Devices	10	10	27-Jul-27	09-Aug-27																				
433	L2-FI-1170	Adjust Fire Sprinkler Drops	7	7	02-Aug-27	10-Aug-27																				
434	L2-FI-1180	Install Ceiling Tile	10	10	11-Aug-27	24-Aug-27																				
435	L2-FI-1190	Install Countertops	2	2	11-Aug-27	12-Aug-27																				
436	L2-FI-1200	Install Perforated Ceiling Panels	5	5	11-Aug-27	17-Aug-27																				
437	L2-FI-1210	Install Visual Display Surfaces	5	5	11-Aug-27	17-Aug-27																				
438	L2-FI-1220	Install Plumbing Finish	10	10	13-Aug-27	26-Aug-27																				
439	L2-FI-1240	Install Floor Coverings	10	10	25-Aug-27	09-Sep-27																				
440	L2-FI-1250	Signage	2	2	25-Aug-27	26-Aug-27																				
441	L2-FI-1230	Install Toilet Partitions & Accessories	5	5	27-Aug-27	02-Sep-27																				
442	L2-FI-1260	Install Doors & Hardware	5	5	10-Sep-27	16-Sep-27																				
443	Finish Grade & Landscape		223	223	08-Dec-26	01-Nov-27																				
444	SITE-FGL-1000	Set Medium Voltage Electrical Equipment	5	5	08-Dec-26	14-Dec-26																				
445	SITE-FGL-1010	Pull & Land Secondary Power to Building	5	5	31-Mar-27	06-Apr-27																				
446	SITE-FGL-1030	Underground Site Lighting	10	10	11-Aug-27	24-Aug-27																				
447	SITE-FGL-1020	Install Sleeves for Landscape	5	5	19-Aug-27	25-Aug-27																				
448	SITE-FGL-1040	Place Final Base Grade for Flatwork	10	10	26-Aug-27	10-Sep-27																				
449	SITE-FGL-1050	Place Reinforcement, Form and Pour Flatwork	20	20	01-Sep-27	30-Sep-27																				
450	SITE-FGL-1060	Install Lateral Lines for Irrigation System	10	10	17-Sep-27	30-Sep-27																				
451	SITE-FGL-1100	Prep Soil for Plant Material	5	5	01-Oct-27	07-Oct-27																				
452	SITE-FGL-1070	Install Guardrails & Handrails	10	10	01-Oct-27	14-Oct-27																				
453	SITE-FGL-1080	Set All Site Lighting	7	7	01-Oct-27	11-Oct-27																				
454	SITE-FGL-1090	Install Site Furnishings	10	10	01-Oct-27	14-Oct-27																				
455	SITE-FGL-1110	Install Plant Material	15	15	05-Oct-27	25-Oct-27																				
456	SITE-FGL-1120	Install New Signage & Striping	3	3	26-Oct-27	28-Oct-27																				
457	SITE-FGL-1130	Place Mulch	3	3	26-Oct-27	28-Oct-27																				
458	SITE-FGL-1140	Landscape Clean Up	2	2	29-Oct-27	01-Nov-27																				
459	Building 1800 Renovation		54	54	29-May-28	14-Aug-28																				
460	Interior		54	54	29-May-28	14-Aug-28																				
461	B1800-INT-1130	Utility Safe-Off - Electrical & Plumbing & Fire Sprinkler	2	2	29-May-28	30-May-28																				
462	B1800-INT-1140	HVAC Rough-In Overhead	5	5	31-May-28	06-Jun-28																				
463	B1800-INT-1150	Select Demo of Interior Finishes	5	5	31-May-28	06-Jun-28																				
464	B1800-INT-1190	Interior Wall Framing	5	5	07-Jun-28	13-Jun-28																				
465	B1800-INT-1180	Fire Sprinkler Modifications	3	3	07-Jun-28	09-Jun-28																				
466	B1800-INT-1390	PH Testing of Slab	1	1	07-Jun-28	07-Jun-28																				
467	B1800-INT-1160	Electrical Modifications Overhead	5	5	12-Jun-28	16-Jun-28																				
468	B1800-INT-1220	HVAC Controls Wall Rough-In	1	1	14-Jun-28	14-Jun-28																				
469	B1800-INT-1250	HVAC Finish	2	2	15-Jun-28	16-Jun-28																				
470	B1800-INT-1210	Electrical Wall Rough-In	5	5	19-Jun-28	23-Jun-28																				
471	B1800-INT-1230	Interior Drywall	10	10	26-Jun-28	11-Jul-28																				
472	B1800-INT-1240	Insulate Interior Walls	2	2	27-Jun-28	28-Jun-28																				
473	B1800-INT-1260	Taping & Topping	10	10	05-Jul-28	18-Jul-28																				



LPC - STEAM Building - #46 - 12.17.25

Project ID: CLPCCD-STEAM-P
Data Date: 17-Dec-25
Run Date: 18-Dec-25
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LIST OF STRUCTURAL TESTS AND SPECIAL INSPECTIONS

- Project has a geotechnical report or construction documents require special inspection by a geotechnical engineer.
- Project does NOT have and does NOT require a geotechnical report.

	TYPE	BY		TYPE	BY
S1 SOILS - GENERAL			C1 CAST-IN-PLACE CONCRETE		
<input checked="" type="checkbox"/> S1a: Site Preparation	Periodic	GE	<input checked="" type="checkbox"/> C1a: Mix Design	Continuous	SI
S2 COMPACTION AND FILL			<input checked="" type="checkbox"/> C1b: Reinforcing Steel	Test	LOR
<input type="checkbox"/> S2a: Fill Materials	Test	LOR*	<input checked="" type="checkbox"/> C1c: Concrete Material	Test	LOR
<input checked="" type="checkbox"/> S2b: Fill Placement	Continuous	GE*	<input checked="" type="checkbox"/> C1d: Strength Test	Test	LOR
<input checked="" type="checkbox"/> S2c: Compaction	Test	LOR*	<input checked="" type="checkbox"/> C1e: Batch Plant Inspection	Continuous	SI
S3 DRIVEN DEEP FOUNDATIONS (PILES)			C2 PRESTRESSED CONCRETE		
<input type="checkbox"/> S3a: Materials and Members	Continuous	GE*	<input type="checkbox"/> C2a: Tendons and Anchorage	Test	LOR
<input type="checkbox"/> S3b: Pile Capacity	Test	LOR*	<input type="checkbox"/> C2b: Tendon Placement	Periodic	SI
<input type="checkbox"/> S3c: Driving Operations	Continuous	GE*	<input type="checkbox"/> C2c: Concrete Strength	Periodic	SI
<input type="checkbox"/> S3d: Pile Installation	Continuous	GE*	<input type="checkbox"/> C2d: Stressing Operations	Continuous	SI
<input type="checkbox"/> S3e: Specialty Piles	*	*	C3 PRECAST CONCRETE		
S4 CAST-IN-PLACE DEEP FOUNDATIONS (PIERS)			<input type="checkbox"/> C3a: General Fabrication	Continuous	SI
<input type="checkbox"/> S4a: Drilling Operations	Continuous	GE*	<input type="checkbox"/> C3b: General Erection	Periodic	SI*
<input type="checkbox"/> S4b: Pier Construction	Continuous	GE*	<input type="checkbox"/> C3c: Diaphragm Connections	Continuous	SI
<input type="checkbox"/> S4c: Bearing Strata	Continuous	GE*	<input type="checkbox"/> C3d: Diaphragm Tolerances	Periodic	SI
S5 RETAINING WALLS			C4 SHOTCRETE		
<input checked="" type="checkbox"/> S5a: Backfill Placement	Continuous	GE*	<input type="checkbox"/> C4a: Placement	Continuous	SI
<input type="checkbox"/> S5b: Soil Reinf. and Drainage	Continuous	GE*	<input type="checkbox"/> C4b: Shotcrete Material	Test	LOR
<input type="checkbox"/> S5c: Segmental Retaining Walls	Continuous	GE*	C5 POST-INSTALLED ANCHORS		
S6 OTHER SOILS			<input checked="" type="checkbox"/> C5a: Inspection	See notes	SI*
<input type="checkbox"/> S6a: Soil Improvement Test	Test	GE*	<input checked="" type="checkbox"/> C5b: Test	Test	LOR
<input type="checkbox"/> S6b: Soil Improvement Inspection	Continuous	GE*	C6 OTHER CONCRETE		
<input type="checkbox"/> S6c: Not used.	N/A	N/A	<input type="checkbox"/> C6a: Not used.	N/A	N/A
<input type="checkbox"/> S6d: Not used.	N/A	N/A	<input type="checkbox"/> C6b: Not used.	N/A	N/A
<input type="checkbox"/> S6e: Not used.	N/A	N/A	<input type="checkbox"/> C6c: Not used.	N/A	N/A
<input type="checkbox"/> S6f: Not used.	N/A	N/A	<input type="checkbox"/> C6d: Not used.	N/A	N/A
<input type="checkbox"/> S6g: Not used.	N/A	N/A	<input type="checkbox"/> C6e: Not used.	N/A	N/A
<input type="checkbox"/> S6h: Not used.	N/A	N/A	<input type="checkbox"/> C6f: Not used.	N/A	N/A
<input type="checkbox"/> S6j: Not used.	N/A	N/A	<input type="checkbox"/> C6g: Not used.	N/A	N/A
<input type="checkbox"/> S6k: Not used.	N/A	N/A	<input type="checkbox"/> C6h: Not used.	N/A	N/A
<input type="checkbox"/> S6m: Not used.	N/A	N/A	<input type="checkbox"/> C6j: Not used.	N/A	N/A
<input type="checkbox"/> S6n: Not used.	N/A	N/A	<input type="checkbox"/> C6k: Not used.	N/A	N/A
<input type="checkbox"/> S6p: Not used.			<input type="checkbox"/> C6m: Not used.		
<input type="checkbox"/> S6q: Not used.			Not used.		
* See Appendix for additional information.			* See Appendix for additional information.		

LIST OF STRUCTURAL TESTS AND SPECIAL INSPECTIONS

	TYPE	BY		TYPE	BY
M1 STRUCTURAL MASONRY fm PSI:			S/A1 STEEL AND ALUMINUM		
<input type="checkbox"/> M1a: Mill Certificates - Reinf.	Periodic	SI*	<input checked="" type="checkbox"/> S/A1a: Material Identification	Periodic	*
<input type="checkbox"/> M1b: Material Certificates	Test	LOR	<input checked="" type="checkbox"/> S/A1b: Unidentified Material	Test	LOR
<input type="checkbox"/> M1c: Strength Test	Test	LOR	<input checked="" type="checkbox"/> S/A1c: Steel Fabrication	Periodic	SI
<input type="checkbox"/> M1d: Mortar Proportions	Periodic	SI	<input type="checkbox"/> S/A1d: Buckling Restrained Brace	Test*	LOR
<input type="checkbox"/> M1e: Grout Proportions	Periodic	SI	S/A2 HIGH-STRENGTH BOLTS		
<input type="checkbox"/> M1f: Batch Plant Inspection		SI	<input checked="" type="checkbox"/> S/A2a: Product Verification	Periodic	SI
<input type="checkbox"/> M1g: Core Tests	Test	LOR	<input checked="" type="checkbox"/> S/A2b: Bolts, Nuts, and Washers	Test	LOR
<input type="checkbox"/> M1h: Prisms	Continuous	SI	<input checked="" type="checkbox"/> S/A2c: Snug Tight	Periodic	SI
<input type="checkbox"/> M1i: Dowels and Supports	Periodic	SI	<input checked="" type="checkbox"/> S/A2d: Pretensioned / Slip-Critical	*	SI
<input type="checkbox"/> M1j: Reinforcement and Members	Periodic	SI	S/A3 WELDING		
<input type="checkbox"/> M1k: Reinforcement Placement	Continuous	SI	<input checked="" type="checkbox"/> S/A3a: Weld Material	Periodic	SI
<input type="checkbox"/> M1l: Grout Placement	Continuous	SI	<input checked="" type="checkbox"/> S/A3b: Certificate of Compliance	Periodic	SI
<input type="checkbox"/> M1m: Unit Layup and Joints	Periodic	SI*	<input checked="" type="checkbox"/> S/A3c: WPS and Qualifications	Periodic	SI
<input type="checkbox"/> M1n: Cold/Hot Weather Work	Periodic	SI	S/A4 SHOP WELDING		
<input type="checkbox"/> M1o: Anchors and Embeds	Continuous	SI	<input checked="" type="checkbox"/> S/A4a: Weld Category A	Continuous	SI
<input type="checkbox"/> M1p: Grout Cavity	Continuous	SI	<input checked="" type="checkbox"/> S/A4b: Weld Category B	Periodic	SI
M2 VENEER OR GLASS BLOCK PARTITIONS			<input checked="" type="checkbox"/> S/A4c: Stairs and Railing	Periodic	SI
<input type="checkbox"/> M2a: Mortar and Grout	Periodic	SI	<input checked="" type="checkbox"/> S/A4d: Reinf. Steel Weldability	Periodic	SI
<input type="checkbox"/> M2b: Unit Layup and Joints	Periodic	SI	<input checked="" type="checkbox"/> S/A4e: Reinforcing Steel	Continuous	SI
<input type="checkbox"/> M2c: Wires and Connector	Periodic	SI	S/A5 FIELD WELDING		
<input type="checkbox"/> M2d: Anchors and Embeds	Periodic	SI	<input checked="" type="checkbox"/> S/A5a: Weld Category A	Continuous	SI
<input type="checkbox"/> M2e: Cold/Hot Weather Work	Periodic	SI*	<input checked="" type="checkbox"/> S/A5b: Weld Category B	Periodic	SI
<input type="checkbox"/> M2f: Adhered Veneer Bond	Test	LOR	<input checked="" type="checkbox"/> S/A5c: End Welded Studs	Periodic	SI
M3 POST-INSTALLED ANCHORS			<input checked="" type="checkbox"/> S/A5d: Deck Welds	Periodic	SI
<input type="checkbox"/> M3a: Inspection	Varies*	SI*	<input checked="" type="checkbox"/> S/A5e: Cold-Formed Steel	Periodic	SI
<input type="checkbox"/> M3b: Test	Test	LOR	<input checked="" type="checkbox"/> S/A5f: Stairs and Railing	Periodic	SI
M4 OTHER MASONRY			<input checked="" type="checkbox"/> S/A5g: Reinf. Steel Weldability	Periodic	SI
<input type="checkbox"/> M4a: Not used.	N/A	N/A	<input checked="" type="checkbox"/> S/A5h: Reinforcing Steel	Continuous	SI
<input type="checkbox"/> M4b: Not used.	N/A	N/A	S/A6 NONDESTRUCTIVE TESTING		
<input type="checkbox"/> M4c: Not used.	N/A	N/A	<input checked="" type="checkbox"/> S/A6a: Ultrasonic	Test	LOR
<input type="checkbox"/> M4d: Not used.	N/A	N/A	<input checked="" type="checkbox"/> S/A6b: Magnetic Particle	Test	LOR
<input type="checkbox"/> M4e: Not used.	N/A	N/A	<input type="checkbox"/> S/A6c: Not used.	N/A	N/A
<input type="checkbox"/> M4f: Not used.	N/A	N/A	<input type="checkbox"/> S/A6d: Not used.	N/A	N/A
<input type="checkbox"/> M4g: Not used.	N/A	N/A	<input type="checkbox"/> S/A6e: Not used.	N/A	N/A
<input type="checkbox"/> M4h: Not used.	N/A	N/A	S/A7 STEEL JOISTS AND TRUSSES		
<input type="checkbox"/> M4j: Not used.	N/A	N/A	<input type="checkbox"/> S/A7a: Fabrication	Continuous	SI
<input type="checkbox"/> M4k: Not used.	N/A	N/A	S/A8 SPRAYED FIRE-RESISTANT MATERIALS		
<input type="checkbox"/> M4m: Not used.			<input type="checkbox"/> S/A8a: Surface and Installation	Periodic	SI
<input type="checkbox"/> M4n: Not used.			<input type="checkbox"/> S/A8b: Density	Test	LOR
<input type="checkbox"/> M4p: Not used.			<input type="checkbox"/> S/A8c: Bond: Adhesion/Cohesion	Test	LOR
* See Appendix for additional information.			* See Appendix for additional information.		

LIST OF STRUCTURAL TESTS AND SPECIAL INSPECTIONS

	TYPE	BY		TYPE	BY
S/A9 ANCHOR BOLTS AND ANCHOR RODS			X OTHER		
<input checked="" type="checkbox"/> S/A9a: Anchor Rods and Bolts	Test	LOR	<input type="checkbox"/> X01: Product Load Test*	Test	LOR
<input checked="" type="checkbox"/> S/A9b: Other Threaded Rods	Test	LOR	<input type="checkbox"/> X02: Non-HSB Installation Torque	Continuous	SI*
S/A10 STORAGE RACK SYSTEMS			<input type="checkbox"/> X03: Not used.	N/A	N/A
<input type="checkbox"/> S/A10a: Material Verification	Periodic	SI	<input type="checkbox"/> X04: Not used.	N/A	N/A
<input type="checkbox"/> S/A10b: Fabrication	Periodic	SI	<input type="checkbox"/> X05: Not used.	N/A	N/A
<input type="checkbox"/> S/A10c: Anchorage	Periodic	SI	<input type="checkbox"/> X06: Not used.	N/A	N/A
<input type="checkbox"/> S/A10d: Completed System	Periodic	SI*	<input type="checkbox"/> X07: Not used.	N/A	N/A
S/A11 OTHER STEEL AND ALUMINUM			<input type="checkbox"/> X08: Not used.	N/A	N/A
<input type="checkbox"/> S/A11a: Not used.	N/A	N/A	<input type="checkbox"/> X09: Not used.	N/A	N/A
<input type="checkbox"/> S/A11b: Not used.	N/A	N/A	<input type="checkbox"/> X10: Not used.	N/A	N/A
<input type="checkbox"/> S/A11c: Not used.	N/A	N/A	EXEMPTIONS		
<input type="checkbox"/> S/A11d: Not used.	N/A	N/A	Those items identified on the DSA-approved construction documents with a note indicating they are not part of the DSA approval or those items checked below are exempt from test and special inspection requirements. The project inspector shall verify all construction complies with the approved construction documents.		
<input type="checkbox"/> S/A11e: Not used.	N/A	N/A	<input type="checkbox"/> Soils: Eligible shallow foundation elements**.		
<input type="checkbox"/> S/A11f: Not used.	N/A	N/A	<input type="checkbox"/> Soils: Eligible deep foundation elements - type 1**.		
<input type="checkbox"/> S/A11g: Not used.	N/A	N/A	<input type="checkbox"/> Soils: Eligible deep foundation elements - type 2**.		
<input type="checkbox"/> S/A11h: Not used.	N/A	N/A	<input type="checkbox"/> Concrete/Masonry: Eligible post-installed anchors**.		
<input type="checkbox"/> S/A11i: Not used.	N/A	N/A	<input type="checkbox"/> Concrete: Batch plant inspection for items listed in and complying with CBC Section 1705A.3.3.2.		
<input type="checkbox"/> S/A11j: Not used.	N/A	N/A	<input checked="" type="checkbox"/> Concrete: Epoxy shear dowels in nonstructural slab-on-grade per CBC Section 1910A.5.4, Exception #4.		
<input type="checkbox"/> S/A11k: Not used.	N/A	N/A	<input type="checkbox"/> Concrete/Masonry: Reinforcing bar testing for items listed in and complying with CBC Section 1910A.2.		
W1 PREFABRICATED WOOD TRUSSES			<input type="checkbox"/> Masonry: Freestanding site walls and retaining walls per DSA IR 21-1.		
<input type="checkbox"/> W1a: Open Web Truss Fabrication	Continuous	SI	<input type="checkbox"/> Concrete: Eligible precast elements**.		
<input type="checkbox"/> W1b: Metal Plate Truss Fabrication	Continuous	SI	<input checked="" type="checkbox"/> Welding: Eligible fences and gates**.		
W2 MANUFACTURED WOOD ELEMENTS			<input checked="" type="checkbox"/> Welding: Eligible railing and ramps**.		
<input type="checkbox"/> W2a: GL Timber Fabrication	Continuous	SI	<input checked="" type="checkbox"/> Welding: Eligible interior cold-formed steel framing**.		
<input type="checkbox"/> W2b: CLT Fabrication	Continuous	SI	<input checked="" type="checkbox"/> Welding: Eligible equipment curbs**.		
<input type="checkbox"/> W2c: Mass Timber Erection	Periodic	SI	<input checked="" type="checkbox"/> Welding: Eligible components supporting MEP distribution systems**.		
<input type="checkbox"/> W2d: Connections Type A	Periodic	SI	<input checked="" type="checkbox"/> Welding: Eligible mounts and recreational equipment**.		
<input type="checkbox"/> W2e: Connections Type B	Continuous	SI	<input checked="" type="checkbox"/> Welding: Eligible nonstructural components**.		
<input type="checkbox"/> W2f: Sealants	Periodic	SI			
W3 OTHER WOOD					
<input type="checkbox"/> W3a: Not used.	N/A	N/A			
<input type="checkbox"/> W3b: Not used.	N/A	N/A			
<input type="checkbox"/> W3c: Not used.	N/A	N/A			
<input type="checkbox"/> W3d: Not used.	N/A	N/A			
<input type="checkbox"/> W3e: Not used.	N/A	N/A			
<input type="checkbox"/> W3f: Not used.	N/A	N/A			
<input type="checkbox"/> W3g: Not used.	N/A	N/A			
<input type="checkbox"/> W3h: Not used.	N/A	N/A			
* See Appendix for additional information.			** See Appendix for eligibility requirements.		

LIST OF STRUCTURAL TESTS AND SPECIAL INSPECTIONS

IMPORTANT: This form is only a summary list of structural tests and some of the special inspections required for the project. Any items indicated on the approved construction documents with a note stating that the items are not part of the DSA approval are not considered in this form. Generally, the structural tests and special inspections noted on this form are those that will be performed by the Geotechnical Engineer of Record, Laboratory of Record, or Special Inspector. The actual complete test and inspection program must be performed as detailed on the DSA approved documents. The appendix at the bottom of this form identifies work NOT subject to DSA requirements for special inspection or structural testing. The project inspector is responsible for providing inspection of all facets of construction, including but not limited to, special inspections not listed on this form such as structural wood framing, high-load wood diaphragms, cold-formed steel framing, anchorage of nonstructural components, etc., per Title 24, Part 2, Chapter 17A.

Legend to TYPE and BY Columns:

Continuous - Indicates continuous special inspection is required.

Periodic - Indicates periodic special inspection is required.

Test - Indicates a test is required.

GE – Indicates special inspection shall be performed by a registered geotechnical engineer or his/her authorized representative, usually associated with the Laboratory of Record.

LOR – Indicates test or special inspection shall be performed by a testing laboratory accepted in the DSA Laboratory Evaluation and Acceptance (LEA) Program (i.e., the Laboratory of Record for the project). See CAC Section 4-335.

PI - Indicates special inspection may be performed by a project inspector when specifically approved by DSA.

SI - Indicates special inspection shall be performed by an appropriately qualified/approved special inspector.

Required Verified Reports:

1. Soils Testing and Inspection: Form DSA 293
2. Structural Testing and Inspection: Form DSA 291
3. Concrete Batch Plant Inspection: Form DSA 291
4. Post-installed Anchors: Form DSA 291 or DSA 292
5. Shop Welding Inspection: Form DSA 291 or DSA 292
6. Field Welding Inspection: Form DSA 291 or Form DSA 292
7. High-Strength Bolting Inspection: Form DSA 291 or DSA 292

Verified reports are required on the following DSA forms:

DSA 291: Laboratory of Record Verified Report

DSA 292: Special Inspectors Employed Directly by the District Verified Report

DSA 293: Geotechnical Verified Report

Note: To facilitate DSA electronic mark-ups and identification stamp application, DSA recommends against using secured electronic or digital signatures.

Name of Architect or Engineer in General Responsible Charge:

Carey Woo

Name of Structural Engineer of Record (when applicable):

David Bleiman

Signature of Architect or Structural Engineer:



Date:

07/24/2025

DSA STAMP

Project Name: **Las Positas College**
School District: **Chabot-Las Positas Community College District**

Application No.: **01-121987** Increment: **2**
File No.: **1-C2**

Appendix: LIST OF STRUCTURAL TESTS AND SPECIAL INSPECTIONS

NOTE: Undefined sections and table references found in this appendix are from the CBC, or California Building Code

S1. GENERAL:	
Test or Special Inspection	Code References and Notes
<p>S1a: Site Preparation Verify that:</p> <ul style="list-style-type: none"> • Site has been prepared properly prior to placement of controlled fill and/or excavations for foundations. • Foundation excavations are extended to proper depth and have reached proper material. • Materials below footings are adequate to achieve the design bearing capacity. 	<p>* By geotechnical engineer or his or her qualified representative. (See Appendix (end of this form) form for exemptions.)</p>

S2. SOIL COMPACTION AND FILL:	
Test or Special Inspection	Code References and Notes
<p>S2a: Fill Materials Perform classification and testing of fill materials.</p>	<p>* Under the supervision of the geotechnical engineer.</p>
<p>S2b: Fill Placement Verify use of proper materials, densities and inspect lift thicknesses, placement and compaction during placement of fill.</p>	<p>* By geotechnical engineer or his or her qualified representative. (Refer to specific items identified in the Appendix (end of this form) form for exemptions where soils SI and testing may be conducted under the supervision of a geotechnical engineer or LOR's engineering manager. In such cases, the LOR's form DSA 291 shall satisfy the soil SI and test reporting requirements for the exempt items.)</p>
<p>S2c: Compaction Compaction testing.</p>	<p>* Under the supervision of the geotechnical engineer. (Refer to specific items identified in the Appendix (end of this form) for exemptions where soils testing may be conducted under the supervision of a geotechnical engineer or LOR's engineering manager. In such cases, the LOR's form DSA 291 shall satisfy the soil test reporting requirements for the exempt items.)</p>

S3. DRIVEN DEEP FOUNDATIONS (PILES):	
Test or Special Inspection	Code References and Notes
<p>S3a: Materials and Members Verify pile materials, sizes and lengths comply with the requirements.</p>	<p>* By geotechnical engineer or his or her qualified representative.</p>
<p>S3b: Pile Capacity Determine capacities of test piles and conduct additional load tests as required.</p>	<p>* Under the supervision of the geotechnical engineer.</p>
<p>S3c: Driving Operations Inspect driving operations and maintain complete and accurate records for each pile.</p>	<p>* By geotechnical engineer or his or her qualified representative.</p>

Project Name: **Las Positas College**
 School District: **Chabot-Las Positas Community College District**

Application No.: **01-121987** Increment: **2**
 File No.: **1-C2**

Appendix: LIST OF STRUCTURAL TESTS AND SPECIAL INSPECTIONS

<p>S3d: Pile Installation Verify locations of piles and their plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and record any pile damage.</p>	<p>* By geotechnical engineer or his or her qualified representative.</p>
<p>S3e: Specialty Piles For specialty piles, perform additional inspections as determined by the registered design professional in responsible charge.</p>	<p>* As defined on drawings or specifications.</p>

S4. CAST-IN-PLACE DEEP FOUNDATIONS (PIERS):

Test or Special Inspection	Code References and Note
<p>S4a: Drilling Operations Inspect drilling operations and maintain complete and accurate records for each pier.</p>	<p>* By geotechnical engineer or his or her qualified representative. (See Appendix (end of this form) for exemptions.)</p>
<p>S4b: Pier Construction Verify pier locations, diameters, plumbness, bell diameters (if applicable), lengths and embedment into bedrock (if applicable); record concrete or grout volumes.</p>	<p>* By geotechnical engineer or his or her qualified representative. (See Appendix (end of this form) for exemptions.)</p>
<p>S4c: Bearing Strata Confirm adequate end strata bearing capacity.</p>	<p>* By geotechnical engineer or his or her qualified representative. (See Appendix (end of this form) for exemptions.)</p>

S5. RETAINING WALLS:

Test or Special Inspection	Code References and Notes
<p>S5a: Backfill Placement Placement, compaction and inspection of backfill.</p>	<p>1705A.6.1. * By geotechnical engineer or his or her qualified representative. (See section S2 above).</p>
<p>S5b: Soil Reinf. and Drainage Placement of soil reinforcement and/or drainage devices.</p>	<p>* By geotechnical engineer or his or her qualified representative.</p>
<p>S5c: Segmental Retaining Walls Segmental retaining walls; inspect placement of units, dowels, connectors, etc.</p>	<p>* By geotechnical engineer or his or her qualified representative. See DSA IR 18-2.</p>

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S6 OTHER SOILS	
Test or Special Inspection	Code References and Notes
S6a Soil Improvements	Submit a comprehensive report documenting final soil improvements constructed, construction observation and the results of the confirmation testing and analysis to CGS (California Geological Survey) for final acceptance. * By geotechnical engineer or his or her qualified representative.
S6b Inspection of Soil Improvements	* By geotechnical engineer or his or her qualified representative.
S6c. Not used.	N/A
S6d. Not used.	N/A
S6e. Not used.	N/A
S6f. Not used.	N/A
S6g. Not used.	N/A
S6h. Not used.	N/A
S6j. Not used.	N/A
S6k. Not used.	N/A
S6m. Not used.	N/A
S6n. Not used.	N/A

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C1. CAST-IN-PLACE CONCRETE	
Test or Special Inspection	Code References and Notes
C1a: Mix Design Verify use of required design mix.	Table 1705A.3 Item 5, 1903A.5, 1903A.7, 1904A.1, 1904A.2, 1910A.1 ; ACI 318 Ch. 19, 26.4, 26.13.3.2.
C1b: Reinforcing Steel Identify, sample, and test reinforcing steel.	Table 1705A.3 Item 1, 1705A.3.9, 1908A.1, 1910A.2; ACI 318 Ch. 20 and Sections 25.2, 25.3, 25.5.1, 26.6.1; DSA IR 17-10 and BU 24-02. (See Appendix (end of this form) for exemptions.)
C1c: Concrete Material During concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	Table 1705A.3 Item 6, 1705A.3.9, 1905A.1.17; ASTM C31, ASTM C172; ACI 318 Sections 26.4, 26.5 & 26.12.
C1d: Strength Test Test concrete (f'c).	1905A.1.17; ACI 318 Section 26.12.
C1e: Batch Plant Inspection Batch plant inspection: Continuous	Default of "Continuous" per 1705A.3.3. If approved by DSA, batch plant inspection may be reduced to "Periodic" subject to requirements in Section 1705A.3.3.1, or not required per 1705A.3.3.2. See IR 17-13. (See Appendix (end of this form) for exemptions.)

C2. PRESTRESSED / POST-TENSIONED CONCRETE (IN ADDITION TO SECTION C1):	
Test or Special Inspection	Code References and Notes
C2a: Tendons and Anchorage Sample and test prestressing tendons and anchorages.	1705A.3.4 Table 1705A.3 Item 1, 1910A.3; ACI 318 Ch. 20 and Sections 25.2, 26.6.1.
C2b: Tendon Placement Inspect placement of prestressing tendons.	1705A.3.4, Table 1705A.3 Items 1 & 9; ACI 318 Ch. 20 and Sections 25.2, 26.6.1-26.6.3.
C2c: Concrete Strength Verify in-situ concrete strength prior to stressing of post-tensioning tendons.	Table 1705A.3 Item 13; ACI 318 Sections 26.10.2, 26.11.2, 26.13.3.3. Special inspector to verify specified concrete strength test prior to stressing.
C2d: Stressing Operations Inspect application of post-tensioning or prestressing forces and grouting of bonded prestressing tendons.	1705A.3.4, Table 1705A.3 Item 9; ACI 318 Sections 26.10.2, 26.13.1, 26.13.3.2.

C3. PRECAST CONCRETE (IN ADDITION TO SECTION C1):	
Test or Special Inspection	Code References and Notes
C3a: General Fabrication 1. Inspect fabrication of precast concrete members. * 2. Inspect reinforcement of the following precast concrete elements or system(s): a. special moment frames. b. boundary elements of special structural walls. c. coupling beams.	1705A.3 Item 1, 7. See Appendix for exemptions. *May be periodic where fabrication occurs in a PCI-certified plant. For underground structures, NPCA plant certification is acceptable. PCI MNL-116-21; PCI MNL-117-13; NPCA Quality Control Manual (QCM) 17th Edition. See IR A-15.

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C3b: General Erection Inspect erection of precast concrete members.	Table 1705A.3 Item 10.
C3c: Diaphragm Connections For precast concrete diaphragm connections or reinforcement at joints classified as moderate or high deformability elements (MDE or HDE) in structures assigned to Seismic Design Category D, E or F, inspect such connections and reinforcement in the field for: 1. Installation of the embedded parts. 2. Completion of the continuity of reinforcement across joints. 3. Completion of connections in the field.	Table 1705A.3 Item 11.
C3d: Diaphragm Tolerances Inspect installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5.	Table 1705A.3 Item 12

C4. SHOTCRETE (IN ADDITION TO SECTION C1):	
Test or Special Inspection	Code References and Notes
C4a: Placement Inspect shotcrete placement for proper application techniques.	1705A.3.9, Table 1705A.3 Item 7, 1908A.1, 1908A.2, 1908A.3. See ACI 506.2 Section 3.4, and ACI 506R.
C4b: Shotcrete Material Sample and test shotcrete (f'_c).	1908A.2 and 1705A.3.9.

C5. POST-INSTALLED ANCHORS:	
Test or Special Inspection	Code References and Notes
C5a: Inspection Inspect installation of post-installed anchors	1617A.1.19, Table 1705A.3 Item 4a (Continuous) & 4b (Periodic), 1705A.3.8 (See Appendix (end of this form) for exemptions). ACI 318 Sections 26.7.2, 26.13.1, 26.13.3.2, 26.13.3.3. * May be performed by the project inspector when specifically approved by DSA.
C5b: Test Test post-installed anchors.	1910A.5. (See Appendix (end of this form) for exemptions.)

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C6. OTHER CONCRETE:	
Test or Special Inspection	Code References and Notes
C6a. Not used.	N/A
C6b. Not used.	N/A
C6c. Not used.	N/A
C6d. Not used.	N/A
C6e. Not used.	N/A
C6f. Not used.	N/A
C6g. Not used.	N/A
C6h. Not used.	N/A
C6j. Not used.	N/A
C6k. Not used.	N/A
C6m. Not used.	Not used.
C6n. Not used.	Not used.

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M1. STRUCTURAL MASONRY:	
Test or Special Inspection	Code References and Notes
M1a: Mill Certificates - Reinf. Mill certificate indicates compliance with requirements for reinforcement, anchors, ties, fasteners and metal accessories. See item C1(b) for identification, sampling and testing of reinforcing steel.	2103A.4; TMS 602-16 Article 1.5B.2 & 2.4. * To be performed by qualified LOR representative. Applicable testing by LOR. See IR 17-10 for unidentified reinforcing steel.
M1b: Material Certificates Producer's certificate of compliance for masonry units, mortar and grout materials.	1705A.4, 2103A.2, 2103A.3, 2103A.5; TMS 602 Articles 1.5B.2, 2.1, 2.2, 2.6A and 2.6B, and Table 6 footnote 3.
M1c: Strength Test Test masonry (f _m).	1705A.4. For Unit Strength: 2105A.3; TMS 602 Articles 1.4B.2, 1.5B.1 & 1.5B.2. For Prism (required when f_m > 2000 psi):2105A.2; TMS 602 Articles 1.4B.3, 1.4B.4, 1.5B.1 & 1.5B.2.
M1d: Mortar Proportions Verify proportions or properties of site-prepared, premixed or preblended mortar.	TMS 602, Table 3 (row 5), Table 4 Item 1a. DSA PR 20-01. (See Appendix (end of this form) for exemptions.)
M1e: Grout Proportions Verify proportions or properties of site-prepared, premixed or preblended grout.	TMS 602, Table 3 (row 5), Table 4 Item 2d. (See Appendix (end of this form) for exemptions.)
M1f: Batch Plant Inspection Batch plant inspection: Periodic	Default of ' Continuous ' per 1705A.3.3 . If approved by DSA, batch plant inspection may be reduced to ' Periodic ' subject to requirements in Section 1705A.3.3.1 , or not required per 1705A.3.3.2 . See IR 17-13. Refer to TMS 602 Table 3 and Table 4, Item #3a. (See Appendix (end of this form) for exemptions.)
M1g: Core Tests Test core-drilled samples.	2105A.4. (See Appendix (end of this form) for exemptions.)
M1h: Prisms Inspect preparation of prisms.	TMS 602 Articles 1.4.B.3 & 1.4.B.4 & Table 4 Item 4.
M1i: Dowels and Supports Verify size, location and condition of all dowels, construction supporting masonry, etc.	
M1j: Reinforcement and Members Verify size, grade and type of reinforcement, connectors, and anchor bolts. Verify size and location of structural members.	TMS 602 Table 4, Items 1c & 3c.
M1k: Reinforcement Placement Inspect placement of reinforcement, anchor bolts, and connectors.	TMS 602 Table 4 Item 2c.
M1l: Grout Placement Placement, consolidation, and reconsolidation of grout.	TMS 602 Table 4 Item 3h.
M1m: Unit Layout and Joints Inspect placement of masonry units and construction of mortar joints.	TMS 602 Table 4 Item 3b.
M1n: Cold/Hot Weather Work Verify preparation, construction and protection of masonry during cold weather (temperature below 40° F) or hot weather (temperature above 90° F).	TMS 602 Table 4 Item 3f. * May be performed by the project inspector when specifically approved by DSA.
M1o: Anchors and Embeds Inspect type, size and location of anchors and all other items to be embedded in masonry including other details of anchorage of masonry	TMS 602 Table 4 Item 3d.

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to structural members, frames and other construction.	
M1p: Grout Cavity Inspect grout space, including mortar protrusions, prior to placement of grout.	TMS 602 Table 4 Item 2a.

M2. VENEER OR GLASS BLOCK PARTITIONS:	
Test or Special Inspection	Code References and Notes
M2a: Mortar and Grout Verify proportions of site prepared mortar and grout and/or verify certification of premixed mortar.	TMS 602 Table 3 (row 5) and Table 4 Items 1a & 2d.
M2b: Unit Layup and Joints Inspect placement of units and construction of mortar joints.	TMS 602 Table 4 Item 3b.
M2c: Wires and Connector Inspect placement of wire, connectors and anchors	TMS 602 Table 4 Item 2c.
M2d: Anchors and Embeds Inspect type, size and location of anchors and all other items to be embedded in masonry veneer including details of anchorage of masonry to veneer backing, frames and other construction.	TMS 602 Table 4 Item 3d.
M2e: Cold/Hot Weather Work Verify preparation, construction and protection of masonry during cold weather (temperature below 40° F) or hot weather (above 90° F).	TMS 602 Table 4 Item 3f. * May be performed by the project inspector when specifically approved by DSA.
M2f: Adhered Veneer Bond Test adhered veneer bond strength.	1410.2.1; TMS 402 Article 12.3.2.4. (Field-constructed mock-up using specified unit, mortar, and substrate, laboratory tested in accordance with ASTM C1823).

M3. POST-INSTALLED ANCHORS IN MASONRY:	
Test or Special Inspection	Code References and Notes
M3a: Inspection Inspect installation of post-installed anchors	1617A.1.19, 1705A.4, Table 1705A.3 Item 4a (Continuous) & 4b (Periodic); ACI 318 Section 26.13. * May be performed by the project inspector when specifically approved by DSA. (See Appendix (end of this form) for exemptions.)
M3b: Test Test post-installed anchors.	1705A.4, 1910A.5. (See Appendix (end of this form) for exemptions.)

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M4. OTHER MASONRY:	
Test or Special Inspection	Code References and Notes
M4a. Not used.	N/A
M4b. Not used.	N/A
M4c. Not used.	N/A
M4d. Not used.	N/A
M4e. Not used.	N/A
M4f. Not used.	N/A
M4g. Not used.	N/A
M4h. Not used.	N/A
M4j. Not used.	N/A
M4k. Not used.	N/A
M4m. Not used.	Not used.
M4n. Not used.	Not used.

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S/A1. STRUCTURAL STEEL, COLD-FORMED STEEL AND ALUMINUM USED FOR STRUCTURAL PURPOSES	
Test or Special Inspection	Code References and Notes
S/A1a: Material Identification Verify identification of all materials and: • Mill certificates indicate material properties that comply with requirements. • Material sizes, types and grades comply with requirements.	Table 1705A.2.1 Item 3a–3c. 2202A.1; AISI S100 Section A3.1 & A3.2, AISI S240 Section A3 & A5, AISI S220 Sections A4 & A6. *By special inspector or qualified technician when performed off-site.
S/A1b: Unidentified Material Test unidentified materials	2202A.1.
S/A1c: Steel Fabrication Verify and document steel fabrication per DSA- approved construction documents.	Not applicable to cold-formed steel light-frame construction, except for trusses (1705A.2.4).
S/A1d: Buckling Restrained Brace Verify and document steel fabrication per DSA-approved construction documents.	Testing and special inspections in accordance with IR 22-4. For DSA accepted fabrication shops, BRB manufacturer's Certificate of Compliance in lieu of testing and special inspections. See IR 22-4.

S/A2. HIGH-STRENGTH BOLTS:	
Test or Special Inspection	Code References and Notes
S/A2a: Product Verification Verify identification markings and manufacturer's certificates of compliance conform to ASTM standards specified in the DSA-approved documents.	Table 1705A.2.1 Items 1a & 1b, 2202A.1; AISC 360 Section A3.3, J3.1, and N3.2; RCSC Section 1.5 & 2.1; DSA IR 17-8 & DSA IR 17-9.
S/A2b: Bolts, Nuts, and Washers Test high-strength bolts, nuts and washers.	Table 1705A.2.1 Item 1c, 2213A.1; RCSC Section 7.2; DSA IR 17-8.
S/A2c: Snug Tight Bearing-type ("snug tight") connections.	Table 1705A.2.1 Item 2a, 1705A.2.6, 2204A.2; AISC 360 J3.1, J3.2, M2.5 & N5.6; RCSC Section 9.1; DSA IR 17-9.
S/A2d: Pretensioned / Slip-Critical Pretensioned and slip-critical connections.	Table 1705A.2.1 Items 2b & 2c, 1705A.2.6, 2204A.2; AISC 360 J3.1, J3.2, M2.5 & N5.6; RCSC Sections 9.2 & 9.3; DSA IR 17-9 **"Continuous" or "Periodic" depends on the tightening method used.

S/A3. WELDING:	
Test or Special Inspection	Code References and Notes
S/A3a: Weld Material Verify weld filler material identification markings per AWS designation listed on the DSA-approved documents and the WPS.	1705A.2.5, Table 1705A.2.1 Items 4 & 5; AWS D1.1 and AWS D1.8 for structural steel; AWS D1.2 for Aluminum; AWS D1.3 for cold-formed steel; AWS D1.4 for reinforcing steel; DSA IR 17-3.
S/A3b: Certificate of Compliance Verify weld filler material manufacturer's certificate of compliance.	DSA IR 17-3.
S/A3c: WPS and Qualifications Verify WPS, welder qualifications and equipment.	DSA IR 17-3.

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S/A4. SHOP WELDING (IN ADDITION TO SECTION S/A3):	
Test or Special Inspection	Code References and Notes
S/A4a: Weld Category A Inspect groove welds, multi-pass fillet welds, single pass fillet welds > 5/16", plug and slot welds.	Table 1705A.2.1 Items 5a.1-4 ; AISC 360 (and AISC 341 as applicable); DSA IR 17-3.
S/A4b: Weld Category B Inspect single-pass fillet welds ≤ 5/16", floor and roof deck welds.	1705A.2.2, Table 1705A.2.1 Items 5a.5 & 5a.6 ; AISC 360 (and AISC 341 as applicable); DSA IR 17-3.
S/A4c: Stairs and Railing Inspect welding of stairs and railing systems.	1705A.2.1 ; AISC 360 (and AISC 341 as applicable); AWS D1.1 & D1.3; DSA IR 17-3.
S/A4d: Reinf. Steel Weldability Verification of reinforcing steel weldability other than ASTM A706.	1705A.3.1 ; AWS D1.4; DSA IR 17-3. Verify carbon equivalent reported on mill certificates.
S/A4e: Reinforcing Steel Inspect welding of reinforcing steel.	Table 1705A.2.1 Item 5b, 1705A.3.1, Table 1705A.3 Item 2, 1903A.8 ; AWS D1.4; DSA IR 17-3.

S/A5. FIELD WELDING (IN ADDITION TO SECTION S/A3):	
Test or Special Inspection	Code References and Notes
S/A5a: Weld Category A Inspect groove welds, multi-pass fillet welds, single pass fillet welds > 5/16", plug and slot welds.	Table 1705A.2.1 Items 5a.1-4 ; AISC 360 (AISC 341 as applicable); DSA IR 17-3.
S/A5b: Weld Category B Inspect single-pass fillet welds ≤ 5/16".	Table 1705A.2.1 Item 5a.5 ; AISC 360 (AISC 341 as applicable); DSA IR 17-3.
S/A5c: End Welded Studs Inspect end-welded studs (ASTM A-108) installation (including bend test).	2213A.2 ; AISC 360 (AISC 341 as applicable); AWS D1.1; DSA IR 17-3.
S/A5d: Deck Welds Inspect floor and roof deck welds.	1705A.2.2, Table 1705A.2.1 Item 5a.6 ; AISC 360 (AISC 341 as applicable); AWS D1.3; DSA IR 17-3.
S/A5e: Cold-Formed Steel Inspect welding of structural cold-formed steel.	1705A.2.5 ; AWS D1.3; DSA IR 17-3. The quality control provisions of AISI S240 Chapter D shall also apply. * May be performed by the project inspector when specifically approved by DSA.
S/A5f: Stairs and Railing Inspect welding of stairs and railing systems.	1705A.2.1 ; AISC 360 (AISC 341 as applicable); AWS D1.1 & D1.3; DSA IR 17-3. * May be performed by the project inspector when specifically approved by DSA.
S/A5g: Reinf. Steel Weldability Verification of reinforcing steel weldability.	1705A.3.1 ; AWS D1.4; DSA IR 17-3. Verify carbon equivalent reported on mill certificates.
S/A5h: Reinforcing Steel Inspect welding of reinforcing steel.	Table 1705A.2.1 Item 5b, 1705A.3.1, Table 1705A.3 Item 2, 1903A.8 ; AWS D1.4; DSA IR 17-3.

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S/A6. NONDESTRUCTIVE TESTING:	
Test or Special Inspection	Code References and Notes
S/A6a: Ultrasonic Ultrasonic	1705A.2.1, Table 1705A.2.1 Item 4c, 1705A.2.5; AISC 341 J6.2, AISC 360 N5.5; AWS D1.1, AWS D1.8; DSA IR 17-2.
S/A6b: Magnetic Particle Magnetic Particle	1705A.2.1, Table 1705A.2.1 Item 4c, 1705A.2.5; AISC 341 J6.2, AISC 360 N5.5; AWS D1.1, AWS D1.8; DSA IR 17-2.
S/A6c: Not used.	N/A
S/A6d: Not used.	N/A
S/A6e: Not used.	N/A

S/A7. STEEL JOISTS AND TRUSSES:	
Test or Special Inspection	Code References and Notes
S/A7a: Fabrication Verify size, type and grade for all chord and web members as well as connectors and weld filler material; verify joist profile, dimensions and camber (if applicable); verify all weld locations, lengths and profiles; mark or tag each joist.	1705A.2.3, Table 1705A.2.3; AWS D1.1; DSA IR 22-3 for steel joists only. 1705A.2.4; AWS D1.3 for cold-formed steel trusses.

S/A8. SPRAYED FIRE-RESISTANT MATERIALS:	
Test or Special Inspection	Code References and Notes
S/A8a: Surface and Installation Examine structural steel surface conditions, inspect application, take samples, measure thickness and verify compliance of all aspects of application with DSA-approved documents.	1705A.15, 1705A.15.1, 1705A.15.2, 1705A.15.3, 1705A.15.4, 1705A.15.5, 1705A.15.6.
S/A8b: Density Test density.	1705A.15.1, 1705A.15.5, ASTM E605
S/A8c: Bond: Adhesion/Cohesion Bond strength adhesion/cohesion.	1705A.15.1, 1705A.15.6, ASTM E736

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S/A9. ANCHOR BOLTS AND ANCHOR RODS:	
Test or Special Inspection	Code References and Notes
S/A9a: Anchor Rods and Bolts Anchor Bolts and Anchor Rods	Identify, sample and test anchor bolts and anchor rods not meeting exemptions identified in Section 1 of IR 17-11.
S/A9b: Other Threaded Rods Threaded rod not used for foundation anchorage.	Identify, sample and test threaded rods not meeting exemptions identified in Section 1 of IR 17-11.

S/A10. STORAGE RACK SYSTEMS:	
Test or Special Inspection	Code References and Notes
S/A10a: Material Verification Materials used, to verify compliance with one or more of the material test reports in accordance with the approved construction documents.	Table 1705A.13.7
S/A10b: Fabrication Fabricated storage rack elements.	1704A.2.5; Table 1705A.13.7
S/A10c: Anchorage Storage rack anchorage installation.	ANSI/MH16.1 Section 7.3.2; Table 1705A.13.7
S/A10d: Completed System Completed storage rack system to indicate compliance with the approved construction documents.	Table 1705A.13.7; * May be preformed by the project inspector when specifically approved by DSA.

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S/A11. Other Steel	
Test or Special Inspection	Code References and Notes
S/A11a. Not used.	N/A
S/A11b. Not used.	N/A
S/A11c. Not used.	N/A
S/A11d. Not used.	N/A
S/A11e. Not used.	N/A
S/A11f. Not used.	N/A
S/A11g. Not used.	N/A
S/A11h. Not used.	N/A
S/A11j. Not used.	N/A
S/A11k. Not used.	N/A
S/A11m. Not used.	Not used.
S/A11n. Not used.	Not used.

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W1. PREFABRICATED WOOD TRUSSES:	
Test or Special Inspection	Code References and Notes
W1a: Open Web Truss Fabrication Inspect fabrication of manufactured open-web trusses.	1705A.5.6 ; DSA IR 23-8.
W1b: Metal Plate Truss Fabrication Inspect fabrication of manufactured metal-plate- connected trusses.	1705A.5.6, 1705A.5.7 ; DSA IR 23-4.

W2. MANUFACTURED WOOD STRUCTURAL ELEMENTS:	
Test or Special Inspection	Code References and Notes
W2a: GLS Timber Fabrication Inspect fabrication of structural glued-laminated timber.*	* See 1705A.5.5 for exceptions
W2b: CLT Fabrication Inspect fabrication of cross-laminated timber.	1705A.5.5
W2c: Mass Timber Erection Inspect erection of mass timber.	Table 1705A.5.3 , Item 2
W2d: Connections Type A Inspect mass timber connections with threaded fasteners, bolts, and/or adhesive anchors other than described in item e below. Inspect concealed mass timber connections.	Table 1705A.5.3 , Items 3.1, 3.3, 3.4, 3.5. For threaded fasteners: Verify use of proper installation equipment. Verify use of pre-drilled holes where required. Inspect screws, including diameter, length, head type, spacing, installation angle, and depth.
W2e: Connections Type B Inspect mass timber connections with adhesive anchors installed in a horizontal or upward orientation.	Table 1705A.5.3 , Item 3.2
W2f: Sealants Inspect application of sealants or adhesives applied to mass timber elements.	1705A.20

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W3. OTHER Wood:	
Test or Special Inspection	Code References and Notes
W3a. Not used.	N/A
W3b. Not used.	N/A
W3c. Not used.	N/A
W3d. Not used.	N/A
W3e. Not used.	N/A
W3f. Not used.	N/A
W3g. Not used.	N/A
W3h. Not used.	N/A
W3j. Not used.	N/A
W3k. Not used.	N/A
W3m. Not used.	Not used.
W3n. Not used.	Not used.

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X1. OTHER:	
Test or Special Inspection	Code References and Notes
X01. Load test for identified product(s):	1709A.2, 1709A.3. Testing is not required for: 1) a product with a valid evaluation service report per DSA IR A-5, or 2) a product that can be justified by structural calculation.
X02. Installation torque for non-HS bolts on communication tower identified as essential service facility projects (ESFP).	Calibrated wrench use required, verified by SI during installation. DSA Policy PL 18-01: Communication Towers, Poles and Buildings Utilized by State Agencies for Essential Services Communications. *EXCEPTION: Non-ESFP may use PI without need for notification to DSA.
X03. Not used.	N/A
X04. Not used.	N/A
X05. Not used.	N/A
X06. Not used.	N/A
X07. Not used.	N/A
X08. Not used.	N/A
X09. Not used.	N/A
X10. Not used.	N/A

EXEMPTIONS

<p>SOILS - EXEMPTIONS:</p> <p>Soils: Eligible shallow foundation elements Shallow foundations, are exempt from special inspections and testing by a Geotechnical Engineer for the following cases: A) buildings without a geotechnical report and meeting the exception Item #1 criteria in CBC Section 1803A.2 supported by native soil (any excavation depth) or fill soil (not exceeding 12" depth per CBC, Section 1804A.6), B) soil scarification/recompaction not exceeding 12" depth, C) native or fill soil supporting exterior non-structural flatwork (e.g., sidewalks, site concrete ramps, site stairs, parking lots, driveways, etc.), D) unpaved landscaping and playground areas, or E) utility trench backfill with depth not exceeding 12". These exempt structures shall be identified on the approved construction documents.</p> <p>Soils: Eligible deep foundation elements, Type 1 Deep foundation acting as cantilever footing with a design based on minimum allowable pressures per CBC Table 1806A.2 and without a geotechnical report are exempt from special inspection and testing by a Geotechnical Engineer for the following cases: A) free standing sign or scoreboard, B) cell or antenna towers and poles less than 35'-0" tall (e.g., lighting poles, flag poles, poles supporting open mesh fences, etc.). These exempt structures shall be identified on the approved construction documents.</p> <p>Soils: Eligible deep foundation elements Type 2 Deep foundation acting as cantilever footing with a design based on minimum allowable pressures per CBC Table 1806A.2 and without a geotechnical report are exempt from special inspection and testing by a Geotechnical Engineer for the following cases: A) single-story open fabric shade structure, or B) covered walkway structure with an apex height less than 10'-0" above adjacent grade. These exempt structures shall be identified on the approved construction documents.</p>
<p>CONCRETE/MASONRY - EXEMPTIONS:</p> <p>Concrete/Masonry: Eligible post-installed anchors Post-installed anchors for the following: A) exempt non-structural components (e.g., mechanical, electrical, plumbing equipment – see item 7 for "Welding" in the Appendix below) given in CBC Section 1617A.1.18 or B) interior nonstructural wall partitions meeting criteria listed in exempt item 3 for "Welding" in the Appendix below.</p> <p>Concrete: Batch plant inspection for items listed in and complying with CBC Section 1705A.3.3.2. Concrete batch plant inspection is not required for items given in CBC Section 1705A.3.3.2 subject to the requirements and limitations in that section.</p> <p>Concrete: Epoxy shear dowels in nonstructural slab-on-grade per CBC Section 1910A.5.4, Exception #4. Epoxy shear dowels in site flatwork and/or other nonstructural concrete.</p> <p>Concrete/Masonry: Reinforcing bar testing for items listed in and complying with CBC Section 1910A.2. Testing of reinforcing bars is not required for items given in CBC Section 1910A.2 subject to the requirements and limitations in that section. These exempt structures shall be identified on the approved construction documents.</p> <p>Masonry: Freestanding site walls and retaining walls per DSA IR 21-1. Freestanding and site retaining masonry walls may be exempt from certain DSA masonry testing and special inspection items as allowed per DSA IR 21-1.</p> <p>Eligible precast elements Structural tests and special inspections are not required for the following concrete precast elements. Provide a certificate of compliance at delivery. Exemptions shall be identified on the approved construction documents.</p> <ol style="list-style-type: none"> 1. Underground vaults no greater than 5 feet x 5 feet x unlimited height and pipe manufactured to an ASTM standard, 5 foot or less in diameter. 2. Elements manufactured in a PCI or NPCA certified manufacturing plant:

Project Name: **Las Positas College**

School District: **Chabot-Las Positas Community College District**

Application No.: **01-121987** Increment: **2**

File No.: **1-C2**

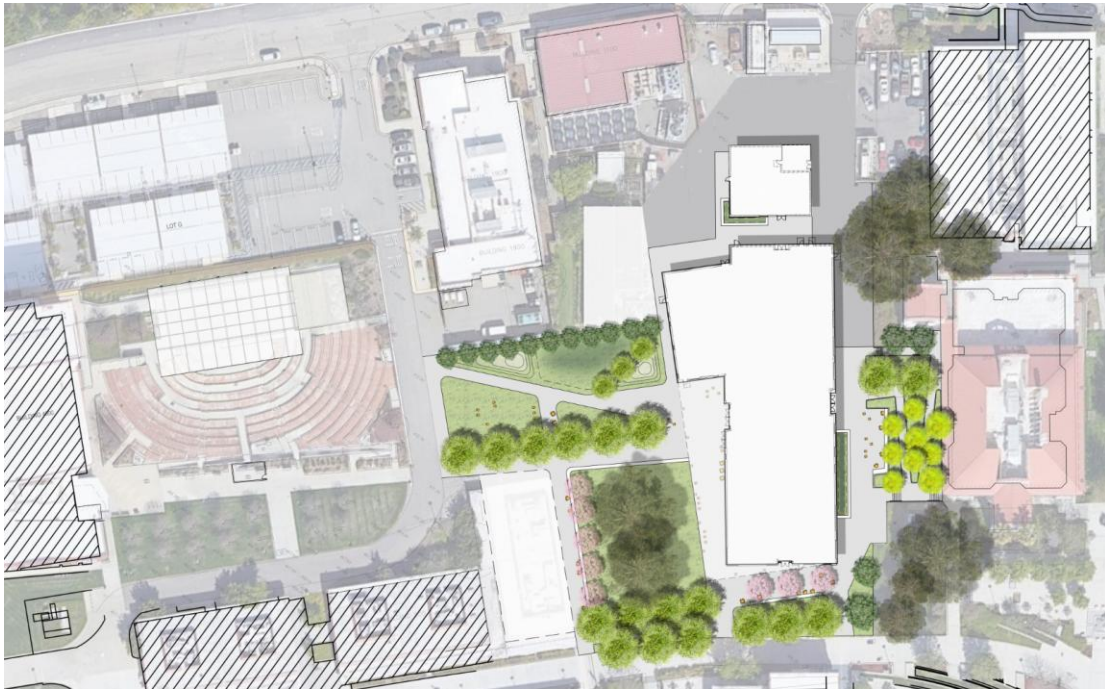
Appendix: LIST OF STRUCTURAL TESTS AND SPECIAL INSPECTIONS

A.	Underground vaults no greater than 16 feet in both length and width, of unlimited height, not subject to loading greater than HS 20-44.
B.	Pipe.
C.	Stair treads, landing planks.

WELDING - EXEMPTIONS:	
Welding: Eligible fences and gates Fences, gates with maximum leaf span of 10', and gates with a maximum rolling section of 10' all having an apex height less than 8'-0" above lowest adjacent grade.	
Welding: Eligible railing and ramps Handrails, guardrails, and modular or relocatable ramps associated with walking surfaces less than 30" above adjacent grade; fillet welds shall not be ground flush.	
Welding: Eligible interior cold-formed steel framing Non-bearing non-shearwall interior cold-formed steel framing spanning less than 15'-0" in height and header less than 10'-0" in opening width, such as in interior partitions, interior soffits, etc.	
Welding: Eligible equipment curbs Manufactured support frames and curbs using hot rolled or cold-formed steel (i.e., light gauge) for mechanical, electrical, or plumbing equipment weighing less than 2000# (equipment only) (connections of such frames to superstructure elements using welding will require special inspection.)	
Welding: Eligible components supporting MEP distribution systems Manufactured components (e.g., Tolco, B-Line, Afcon, etc.) for mechanical, electrical, or plumbing hanger support and bracing (connections of such components to superstructure elements using welding will require special inspection.)	
Welding: Eligible mounts and recreational equipment TV Brackets, projector mounts with a valid listing (see DSA IR A-5) and recreational equipment (e.g., playground structures, basketball backstops, etc.) (connections of such elements to superstructure elements using welding will require special inspection.)	
Welding: Eligible nonstructural components Any support for exempt non-structural components given in CBC Section 1617A.1.18 meeting the following: A) when supported on a floor/roof, <400# and resulting composite center of mass (including component's center of mass) ≤4' above supporting floor/roof, B) when hung from a wall or roof/floor, and <20# for discrete units or <5 plf for distributed systems.	

ss

PROJECT MANUAL



STEAM BUILDING PROJECT INCREMENT II – B1500 / B1800 PACKAGE

PERMIT SET

For Issue: July 24, 2025

Prepared for:



LAS POSITAS
COLLEGE







LAS POSITAS COLLEGE
3000 Campus Hill Dr, Livermore, CA, United States, California

SG Project No: 14794

Prepared by:

SMITHGROUP

SECTION 000107 - SEALS PAGE

<p>Architect SmithGroup, Inc.</p> 	<p>Mechanical Engineer</p> 
<p>Electrical Engineer</p> 	<p>Plumbing Engineer</p> 
<p>Structural Engineer</p> 	<p>Civil Engineer</p>  <p>MICHAEL A. KUYKENDALL R.C.E. NO. 70870, EXPIRES 6-30-27</p>

<p>Fire Protection</p>  <p>07/24/2025</p>	<p>Audio/Visual / Security / Technology</p> 
<p>NOT USED</p>	<p>Landscaping</p> 

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PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes summary of work including:
 - 1. Work covered by Contract Documents
 - 2. Bid items and Allowances
 - 3. Work sequence
 - 4. Cooperation of contractor and coordination with other work
 - 5. Maintenance
 - 6. Occupancy requirements
 - 7. Reference Standards
 - 8. Products ordered in advance
 - 9. District furnished products
 - 10. Specification and Drawing Conventions

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. SCOPE OF WORK: Increment II - New Building 1500 and Building 1800 Renovations
- B. The work shall include all work shown and specified except for work indicated "N.I.C" or "Not in Contract".
- C. The Contractor must maintain access to the existing buildings at all times during the project. The contractor is to provide secure fencing and/or barricades to keep the general public from entering exterior work areas and contractor laydown areas. Fencing is required to have a privacy screen.
- D. Unless provided otherwise in the Contract Documents, all risk of loss of Work covered by the Contract Documents shall rest with the Contractor until Final Completion and Acceptance of the Work.

1.3 BID ITEMS AND ALLOWANCES

- A. Base Bid - Furnish and install all work shown on Drawings and described in Specifications and all other Contract Documents, including connections to existing systems for a complete and operational product.
- B. Allowances - A District's unspecified allowance is as noted in Paragraph 1.1 of the Bid Proposal. Other Allowances may be required to be determined.

1.4 WORK SEQUENCE

- A. The contractor shall coordinate their work with the Construction Manager. Work will be performed on an active college campus. Campus buildings are generally in use from 7:30 AM to 10:30 PM Monday through Friday and 7:30 AM to 5:30 PM on Saturday. Contractor shall provide to the Construction Manager a sequence of work and regular updates as agreed upon in the pre-construction meeting.

1.5 COOPERATION OF CONTRACTOR AND COORDINATION WITH OTHER WORK.

- A. Should construction work, or work of any other nature, be underway by District or other forces or by other contractors within or adjacent to the limits of the Work at the time the Work was advertised for bids, the Contractor shall cooperate with all such other contractors or forces to the end that any delay or hindrance to their work will be avoided. The cost of such cooperation will be considered as included in the prices bid and no direct or additional payment will be made therefore. Contractor shall coordinate with such other contractors and forces as required by General Conditions.

- B. District reserves the right to perform other or additional work, within or adjacent to the limits of the work specified, at any time by the use of other forces. Contractor shall coordinate with District and any District forces, or other forces, engaged by District, as required by General Conditions. In the event that the performance of such other or additional work materially increases or decreases Contractor's costs, the work and the amount to be paid therefore will be appropriately adjusted as determined by the Construction Manager.
- C. Limit use of the Site for Work and for construction operations to allow for:
 - 1. District operation
 - 2. Work by other contractors and tenants
- D. Coordinate use of the Site and access to site with other contractors, utilities, and District forces, as required by General Conditions. Construction Manager has final authority over coordination, use of the Site, and access to site.
- E. Cooperate with District and others who may occupy and begin work on site and inside building prior to completion of Work of this Contract.
- F. Cooperate with contractors for other area work, not included in Contract, but which may take place during construction period.

1.6 MAINTENANCE

- A. Cost of maintenance of systems and equipment prior to Final Acceptance will be considered as included in prices bid and no direct or additional payment will be made therefore.

1.7 OCCUPANCY REQUIREMENTS

- A. Whenever, in the opinion of Construction Manager, Work or any part thereof is in a condition suitable for use, and the best interest of District requires such use, District may take beneficial occupancy of and connect to, open for public use, or use the Work or such part thereof. In such case, District will request Architect/Engineer to inspect the Work or part thereof, and issue a Certificate of Substantial Completion for that part of Work.
- B. Prior to date of Final Acceptance of the Work by District, all necessary repairs or renewals in Work or part thereof so used, due to ordinary wear and tear, or due to defective materials or workmanship or to operations of Contractor, shall be made at expense of Contractor, as required in General Conditions.
- C. Use by District of Work or part thereof as contemplated by this section shall in no case be construed as constituting acceptance of Work or any part thereof. Such use shall neither relieve Contractor of any responsibilities under Contract, nor act as waiver by District of any of the conditions thereof.
- D. District may specify in the Contract Documents that portions of the Work, including electrical and mechanical systems or separate structures, shall be substantially completed on milestone dates prior to substantial completion of all of the Work. Contractor shall notify Architect/Engineer in writing when Contractor considers any such part of the Work ready for its intended use and substantially complete and request Architect/Engineer to issue a Certificate of Substantial Completion for that part of the Work.

PART 2 - PRODUCTS

2.1 REFERENCE STANDARDS

- A. For products specified by association or trade standards, comply with requirements of standard, except where more rigid requirements are specified or are required by applicable codes.

2.2 PRODUCTS ORDERED IN ADVANCE

- A. If products are ordered by the District or Contractor in advance provide list of products, model and date or order here. If none are provide include "Not Applicable".

2.3 DISTRICT FURNISHED PRODUCTS

- A. District furnished products as specified, if any, are indicated on Construction Documents.

PART 3 - EXECUTION

3.1 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
 - 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
 - 4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings, indicated in the Specifications, and as published as part of the U.S. National CAD Standard.
 - 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

END OF SECTION

SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Related Requirements:
 - 1. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 2. Section 014000 "Quality Requirements" for field testing by an independent testing agency.

1.2 DEFINITIONS

- A. Unit price is an amount incorporated into the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.3 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

- A. Unit Prices, General: Refer to Sections indicateing Unit Prices and referring to this Section.

END OF SECTION 012200

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes general procedural requirements for alterations, modifications and extras.
- B. Related Sections
 - 1. Section 011100: Summary of Work

1.2 GENERAL

- A. Any change in scope of work or deviation from Drawings or Specifications shall be accomplished only when authorized in writing by Construction Manager in accordance with General Conditions Article 9. As appropriate, change orders are subject to approval by the Division of the State Architect. Refer to section 4-338, Part 1, Title 24, California Code of Regulations, and the CLPCCD Board of Trustees as appropriate.
- B. Changes in the scope of Work or deviation from Drawings or Specification may not be initiated by use of the following methods:
 - 1. Request for Information (RFI): Request for information shall be in accordance with General Conditions Paragraph 3.1.10. If a change in scope or cost is required by the Architect/Engineer response to the RFI the contractor shall submit a change order request per Article 9 of the General Conditions
 - 2. Request for Substitution (RFS) Request for alternates or substitutes shall be in accordance with General Conditions Paragraph 4.8.2.
- C. Changes in scope of Work or deviation from Drawings or Specifications may be initiated only by the Contractor or the Construction Manager.
 - 1. Contractor may initiate changes by submitting: Change Order Request; Notice of Concealed or Unknown Conditions, or Notice of Hazardous Waste Conditions.
 - a. Notices of Changes shall be submitted in accordance with paragraph 9.6 of General Conditions.
 - b. Notices of Hazardous Waste Conditions shall be submitted in accordance with paragraph 4.17 of General Conditions.
 - c. Notices of concealed or unknown conditions shall be submitted to make Owner aware of a potential change in scope of the work.
 - 2. Contractor shall be responsible for its costs to implement and administer RFI's and RFS's throughout the Contract duration. Regardless of the number of RFI's submitted, Contractor will not be entitled to additional compensation. Contractor shall be responsible for both CLPCCD's and Architect's administrative costs for answering its RFI's where the answer could reasonably be found by reviewing the Contract Documents, as determined by CLPCCD; such costs will be deducted from progress payments, in accordance with General Conditions 3.1.10.
 - 3. Architect/Engineer may initiate changes by issuing a Supplemental Instruction (which shall require written approval of the Construction Manager).
 - 4. Construction Manager may initiate changes by issuing Requests for Proposal (RFP) or a Field Change Notice (FCN) to Contractor. Such RFP's or FCN's will detail all proposed changes in the Work and request a quotation of changes in Contract Sum and Contract Times from Contractor. A RFP or FCN may require Contractor to expedite the work and proceed on a time and material (force account) basis.

1.3 PROCEDURE

- A. Contractor shall submit RFI to Construction Manager. Contractor shall reference each RFI to an activity on its Progress Schedule and note the time criticality of the RFI, indicating the time in which the response is required. Architect/Engineer shall respond by issuing a Clarification.
 - 1. If Contractor is satisfied with the Clarification and does not request change in Contract Sum or Contract Times, then the Clarification shall be executed without a change.
 - 2. If Contractor believes that the Clarification results in change in Contract Sum or Contract Times, Contractor shall notify Construction Manager who may then deny request for change or issue RFP.
- B. Contractor shall submit RFS to Construction Manager within 35 days of award of contract in accordance with General Conditions paragraph 4.8.
- C. Contractor shall submit Notices of Changes to resolve unanticipated conditions incurred in the execution of the Work. Procedures in Paragraph 9.6 of General Conditions shall be followed. If Construction Manager determines that a change in Contract Sum or contract Times is justified, Construction Manager shall issue RFP.
- D. Contractor shall submit Notices of Hazardous Waste Conditions to resolve problems regarding hazardous materials encountered in the execution of the Work. Procedures in Paragraph 4.17 of General Conditions shall be followed. If Construction Manager determines that a change in Contract Sum or contract Times is justified, Construction Manager shall issue RFP.
- E. Architect/Engineer shall issue Supplemental Instruction to the Construction Manager who shall forward onto Contractor. Contractor shall not proceed with Supplemental Instruction until Construction Manager approves it in writing.
 - 1. If Contractor is satisfied with Supplemental Instruction and does not request change in Contract Sum or Contract Times, then Supplemental Instruction shall be executed without a Change Order.
 - 2. If Contractor believes that Supplemental Instruction results in change in Contract Sum or Contract Times, Contractor shall notify Construction Manager. Construction Manager may then deny request for change, cancel Clarification or issue RFP.
- F. Responses by recipients shall be within a reasonable time.
- G. Contractor shall respond to Construction Manager's RFP within fifteen (15) working days by furnishing a complete breakdown of costs of both credits and extras; itemizing materials, labor, taxes, overhead and profit. Subcontract work shall be so indicated.
- H. Upon approval of RFP, Construction Manager will issue a Change Order directing Contractor to proceed with extra work.
- I. Payment shall be made as follows:
 - 1. Change Orders which increase Contract Sum or Contract Times shall be included in next Contract Modification Form, signed by Construction Manager, accepted by Contractor.
 - 2. Payment shall be made for Change Order work along with other work in progress payment following completion of Change Order work. Partial completion of Change Order work shall be paid for that part completed during the period covered by the monthly payment request.

1.4 COST DETERMINATION

- A. Total cost of extra work shall be the sum of labor costs, material costs, equipment rental costs and specialist costs as defined herein plus overhead and profit as allowed herein. This limit applies in all cases of claims for extra work, whether calculating Change Orders, or calculating claims of all types, and applies even in the event of fault, negligence, strict liability, or tort claims of all kinds, including misrepresentation, concealment, strict liability or negligence. No other costs arising out of or connected with the performance of extra work, of any nature, may be recovered by Contractor. No special, incidental or consequential damages may be claimed or recovered against CLPCCD, its representatives or agents, whether arising from breach of contract, negligence or strict liability, unless specifically authorized in the Contract Documents.
- B. Overhead:
 - 1. Overhead shall be as defined in Paragraph 1.08.
- C. Taxes:
 - 1. Alameda County Sales Tax should be included.
 - 2. Federal and Excise Tax shall not be included.
- D. Owner Operated Equipment: When owner-operated equipment is used to perform extra work, Contractor will be paid for equipment and operator as follows:
 - 1. Payment for equipment will be made in accordance with Paragraph 1.05. C.
 - 2. Payment for cost of labor will be made at no more than rates of such labor established by California prevailing wage agreements for type of worker and location of work, whether or not owner-operator is actually covered by such an agreement.

1.5 COST BREAKDOWN

- A. Labor - Contractor will be paid cost of labor for workers (including fore persons when authorized by Construction Manager) used in actual and direct performance of extra work. Labor rate, whether employer is Contractor, subcontractor or other forces, will be sum of following:
 - 1. **Actual Wages** - Actual wages paid shall be limited to the applicable prevailing wage rate for the classification of labor actually and reasonably necessary to complete a Change. Prevailing wage rates shall be deemed to include all direct payment of wages to workers completing a Change and all employer burdens thereon, including without limitation all employer payments to or on behalf of workers for Workers Compensation, health and welfare, pension, vacation and other similar labor burdens. Contractors and subcontractors are required to provide their corresponding wage rate breakdown for the classification of labor under which they will complete a Change and on the form provided by the Owner for review and approval by the Owner and Construction Manager prior to processing and approval of payment for any completed Change.
- B. Material - Only materials furnished by Contractor and necessarily used in performance of extra work will be paid for. Cost of such materials will be cost, including sales tax, to purchaser (Contractor, subcontractor or other forces) from supplier thereof, except, as the following are applicable:
 - 1. If cash or trade discount by actual supplier is offered or available to purchaser, it shall be credited to the District notwithstanding fact that such discount may not have been taken.
 - 2. For materials salvaged upon completion of extra work, salvage value of materials shall be deducted from cost, less discount, of materials.
 - 3. If cost of a material is, in opinion of Construction Manager, excessive, then cost of material shall be deemed to be lowest current wholesale price at which material is available in quantities concerned delivered to Site, less any discounts as provided in subparagraph 1 above.

- C. Equipment Rental - For Contractor or subcontractor-owned equipment, payment will be made at the lesser of actual rental rates or the rental rates listed for equipment in California Department of Transportation official equipment rental rate schedule which is in effect on date upon which extra work is accomplished and which schedule is incorporated herein by reference as though fully set forth herein. For rented equipment, payment will be made based on actual rental invoices. Equipment used on extra work shall be of proper size and type. If, however, equipment of unwarranted size or type and cost is used, cost of use of equipment shall be calculated at rental rate for equipment of proper size and type. Rental rates paid shall be deemed to cover cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, and all incidentals. Unless otherwise specified, manufacturer's ratings, and manufacturer-approved modifications, shall be used to classify equipment for determination of applicable rental rates. Individual pieces of equipment or tools not listed in said publication and having a replacement value of five hundred dollars (\$500) or less, whether or not consumed by use, shall be considered to be small tools and no payment will be made therefore as payment is included in payment for labor. Rental time will not be allowed while equipment is inoperative due to breakdowns.
1. For equipment on Site, rental time to be paid for equipment shall be the time equipment is in operation on extra work being performed. The following shall be used in computing rental time of equipment:
 - a. When hourly rates are listed, less than thirty (30) minutes of operation shall be considered to be one-half (1/2) hour of operation.
 - b. When daily rates are listed, less than four (4) hours of operation shall be considered to be one-half (1/2) day of operation. Anything over four (4) hours and not more than eight (8) hours is considered one (1) full day of operation.
 2. For equipment, which must be brought to Site to be used exclusively on extra work, cost of transporting equipment to Site and its return to its original location shall be determined as follows:
 - a. District will pay for costs of loading and unloading equipment.
 - b. Cost of transporting equipment in low bed trailers shall not exceed hourly rates charged by established haulers.
 - c. Cost of transporting equipment shall not exceed applicable minimum established rates of California Public Utilities Commission.
 - d. Payment for transporting, and loading and unloading equipment as above provided will not be made if equipment is used on Work in any other way than upon extra work.
 3. Rental period shall begin at time equipment is unloaded at Site of extra work and terminate at end of day on which Construction Manager directs Contractor to discontinue use of equipment. Excluding Saturdays, Sundays, and legal holidays, unless equipment is used to perform extra work on such days, rental time to be paid per day shall be four (4) hours for zero (0) hours of operation, six (6) hours for four (4) hours of operation and eight (8) hours for eight (8) hours of operation, time being prorated between these parameters. Hours to be paid for equipment, which is operated less than eight (8) hours due to breakdowns, shall not exceed eight (8) less number of hours equipment is inoperative due to breakdowns.
- D. Work Performed by Special Forces or Other Special Services - When Construction Manager and Contractor, by agreement, determine that special service or item of extra work cannot be performed by forces of Contractor or those of any subcontractors, service or extra work item may be performed by specialist. Invoices for service or item of extra work on basis of current market price thereof may be accepted without complete itemization of labor, material, and equipment rental costs when it is impracticable and not in accordance with established practice of special service industry to provide complete itemization. In those instances, wherein, Contractor is required to perform extra work necessitating a fabrication or machining process in a fabrication or machine shop facility away from Site, charges for that portion of extra work performed in such facility may, by agreement, be accepted as a specialist billing. Construction Manager must be notified in advance of all offsite work. To specialist invoice price, less credit to District for any cash or trade discount offered or available, whether or not such discount may have been taken, will be added 15 percent (15%) in lieu of overhead and profit provided in Paragraph 1.04.B.

1.6 FORCE-ACCOUNT

- A. If it is impracticable because of nature of work, or for any other reason, to fix an increase or decrease in price definitely in advance, Change Order may fix a maximum price which shall not under any circumstances be exceeded, and subject to such limitation, such alteration, modification or extra shall be paid for at actual necessary cost as determined by District Authority, which cost shall be determined pursuant to Article 1.04, and shall be known as Force-Account work.
- B. Whenever any Force-Account work is in progress, definite price for which has not been agreed on in advance, Contractor shall report to Construction Manager each day in writing in detail amount and cost of labor and material used, and any other expense incurred in Force-Account work on preceding work day, and no claim for compensation for Force-Account work will be allowed unless report shall have been made. Daily report(s) shall be delivered to Construction Manager within one (1) business day of the day the work was performed. No late reports will be accepted. The intent is to have daily agreement on hours expended for labor and equipment on Force-Account work.
- C. Above described methods of determining payment for work and materials shall not apply to performance of work or furnishings of material, which, in judgment of Construction Manager, may properly be classified under items for which prices are established in Contract.

1.7 DISTRICT FURNISHED MATERIALS

- A. District reserves right to furnish materials, as it deems advisable, and Contractor shall have no claims for costs and overhead and profit on such materials.

1.8 OVERHEAD DEFINED

- A. The following constitutes charges that are included in overhead for all contract modifications, including Force-Account work:
 - 1. Drawings: field drawings, shop drawings, etc. including submissions of drawings
 - 2. Routine field inspection of work proposed
 - 3. General Superintendence
 - 4. General administration and preparation of change orders
 - 5. Computer services
 - 6. Reproduction services
 - 7. Salaries of project engineer, Construction Manager, superintendent, timekeeper, storekeeper and secretaries
 - 8. Janitorial services
 - 9. Temporary on-site facilities:
 - a. Offices
 - b. Telephones
 - c. Plumbing
 - d. Electrical: Power, lighting
 - e. Platforms
 - f. Fencing, etc.
 - 10. Home office expenses
 - 11. Insurance Premium
 - 12. Procurement and use of vehicles and fuel used coincidentally in base bid work
 - 13. Surveying
 - 14. Estimating
 - 15. Protection of work
 - 16. Final cleanup
 - 17. Other incidental work
 - 18. Record Drawings
 - 19. Warranty
 - 20. Transportation expense to site for labor

1.9 RECORDS AND CERTIFICATION

- A. Force-Account (cost reimbursement) charges shall be recorded daily upon Cost Breakdown for Contract Modification Form obtained from Inspector. Contractor or authorized representative shall complete and sign form. Inspector shall sign form for approval. Contract Modification Form shall provide names and classifications of workers and hours worked by each, itemize materials used, and also list size type and identification number of equipment, and hours operated, and shall indicate work done by specialists.
- B. No payment for Force-Account work shall be made until Contractor submits original invoices substantiating materials and specialist charges.
- C. District shall have the right to audit all records in possession of Contractor relating to activities covered by Contractor's claims for modification of Contract, including Force-Account work, as set forth in General Conditions.
- D. Further, District shall have right to audit, inspect, or copy all records maintained in connection with this Contract, including financial records, in possession of Contractor relating to any transaction or activity occurring or arising out of, or by virtue of, Contract. If Contractor is a joint venture, right of District shall apply collaterally to same extent to records of joint venture sponsor, and of each individual joint venture member.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

Sample Cost Breakdown form attached.

SAMPLE ONLY

COST BREAKDOWN FORM FOR CONTRACT MODIFICATION

One separate form shall be used by Contractor, each first tier subcontractor and each lower tier subcontractor. One form for each shall be used for each change order. One form for each, for each day shall be used for Force-Account work.

COST BREAKDOWN FOR CONTRACTOR PRICE PROPOSAL

SHEET 1 OF 3

GENERAL CONTRACTOR FORM

PROJECT NUMBER: _____

PROJECT NAME: _____

CONTRACTOR : _____

CHANGE ORDER NUMBER : _____ DATE: _____

CHANGE ORDER DESCRIPTION: _____

SUMMARY OF TOTAL COSTS				
1. TOTAL LABOR COSTS		\$		
		-		
2. Fifteen percent (15%) of Line 1		\$		
		-		
3. Sum of Lines 1 & 2			\$	
			-	

4. TOTAL MATERIAL COSTS		\$ -		
5. Fifteen percent (15%) of Line 4		\$ -		
6. Sum of Lines 4 & 5			\$ -	
7. TOTAL EQUIPMENT RENTAL COSTS		\$ -		
8. Fifteen percent (15%) of line 7		\$ -		
9. Sum of lines 7 & 8			\$ -	
10. TOTAL OF SUBCONTRACTED COST		\$ -		
11. Five percent (5%) of line 10 (excluding subcontractor markup)		\$ -		
12. Sum of Lines 10 & 11			\$ -	
SUBTOTAL OF DIRECT COSTS & MARK-UP				\$ -
COST OF BONDS (does not apply to subcontractors)				\$ -
TOTAL OF CONTRACT MODIFICATION				\$ -

COST BREAKDOWN FOR CONTRACTOR PRICE PROPOSAL

SHEET 2 OF 3

CONTRACTOR :

CHANGE ORDER NUMBER :

DATE:

CHANGE ORDER DESCRIPTION: _____

LABOR				
NAME	CLASSIFICATION	HOURS	RATE	TOTAL
				\$ -
				\$ -
				\$ -
				\$ -
TOTAL LABOR COSTS (Transfers to Line 1 of Sheet 1)				\$ -

MATERIALS	
DESCRIPTION	COST
SUBTOTAL MATERIAL COSTS (Without Sales Tax)	\$ -
SALES TAX ON MATERIAL AT 9.00%	\$ -
TOTAL MATERIAL COSTS (Transfers to Line 4 of Sheet 1)	\$ -

EQUIPMENT				
SIZE AND TYPE	I.D. #	HOURS	RATE	TOTAL
				\$ -
				\$ -
				\$ -
				\$ -
TOTAL EQUIPMENT RENTAL COSTS (Transfers to Line 7 of Sheet 1)				\$ -

COST BREAKDOWN FORM FOR CONTRACT MODIFICATION

SHEET 3 OF 3

CHANGE ORDER NUMBER : _____ DATE: _____

CHANGE ORDER DESCRIPTION: _____

SUBCONTRACTED WORK		
SUBCONTRACTOR	DESCRIPTION OF WORK SUBCONTRACTED	COST

TOTAL COST OF SUBCONTRACTED WORK (Transfers to Line 10 of Sheet 1)	\$ -
--	---------

CONTRACTOR: _____ Date: _____

VERIFIED BY INSPECTOR: _____ Date: _____

SECTION 013100 - PROJECT COORDINATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Project coordination.
- B. Field engineering.
- C. Coordination drawings.
- D. Workmanship.
- E. Incidental costs.
- F. Correspondence and Notices.
- G. Miscellaneous provisions.
- H. Damage and restoration.

1.2 RELATED SECTIONS

- A. Section 011100 - Summary of Work.
- B. Section 014500 - Quality Control.
- C. Section 015000 – Temporary Facilities.
- D. Section 017000 - Contract Closeout.

1.3 PROJECT COORDINATION

- A. Coordination scheduling, submittals, and Work of the various Sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate space requirements and installation of mechanical and electrical work, which are indicated diagrammatically on drawings. Follow route shown for pipes, ducts, and conduit, as closely as practicable: place runs parallel with line of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finished elements.
- E. Submit a copy of site drawing and certificate signed by the Civil Engineer that the elevations and locations of the Work of separate Sections in preparation for Substantial Completion.
- F. Coordinate completion and cleanup of Work of separate Sections in preparation for Substantial Completion.

- G. After Owner occupancy of the Site, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.4 FIELD ENGINEERING

- A. Contractor shall locate and protect survey control and reference points.
- B. Control datum for survey is that shown on drawings.
- C. Contractor shall verify setbacks and easements; confirm drawing dimensions and elevations.
- D. Provide field engineering services. Contractor shall establish lines, and levels, utilizing recognized engineering practices

1.5 COORDINATION DRAWINGS

- A. Provide information required by Architect for preparation of coordination drawings.
- B. Review drawings prior to submission to Architect.

1.6 WORKMANSHIP

- A. Work shall be performed by craftsmen well experienced and competent in their particular trade.
- B. Workmanship shall be thorough, finished and complete in every detail for finest quality installations as intended under these specifications.

1.7 INCIDENTAL COSTS

- A. In addition to cost associated with General Conditions Article 6: Insurance; Indemnity; Bonds:
 - 1. Utilities: Refer to Section 015000.
 - 2. Contractors and Subcontractors shall furnish at their own cost and expense all tools, consumable supplies, appliances, equipment, etc., necessary for execution of their work; and shall be responsible for care and guarding thereof.
 - 3. Contractors and Subcontractors shall be entirely responsible for professional, trade, business or other licenses required by state statute or local government.

1.8 CORRESPONDENCE AND NOTICES

- A. Clearly identify correspondence, notices and submittals with project name, subject and detailed references to drawings and specifications.
- B. Notify Inspector or the Construction Manager two (2) working days in advance of required inspection.
- C. The District's project management system (ProjectTeams) shall be utilized for document controls for RFI, Submittals, Daily Logs, etc...

1.9 MISCELLANEOUS PROVISIONS

- A. Contractor shall immediately refer to the Construction Manager any requirement shown or specified which Contractor in their experience and background finds or believes:
 - 1. Is not equal to industry standards for achieving a first quality installation as intended;
 - 2. Is excessive in cost or effort to affect the intended results;
 - 3. Is below standard for proper enforcement of the guarantees required;
 - 4. Or, is at variance with governing laws, regulations, codes or standards.

- B. Work operations relative to any matter referred to Architect for consideration shall not proceed until receipt of appropriate instructions from Architect.
- C. Inspection of Work and Materials: Contractor shall immediately make a close and thorough inspection of all materials as delivered and all work in progress; shall promptly reject and return all defective materials and re-do; and shall check and verify adequate performance or satisfactory results of all tests and inspections before allowing sub-work to proceed.
- D. Warranty Period: During warranty periods, supervise investigation and correction of deficiencies found or occurring in the work.
- E. Shop Fabricate and pre-assemble interrelated parts where possible.
- F. Closing up of walls, partitions or furred spaces, backfilling and other covering up operations shall not proceed until all enclosed or covered work and inspections have been completed. Verify before proceeding.
- G. Provide holes, slots, cutouts, blocking, screeds, nailers, chases and similar preparation as the work progresses, as required to receive or pass subsequent work without damage to previously completed work.
- H. Exterior Work shall be made tight against direct or indirect entry of water into the concealed or interior spaces of the building. Seal joints or penetrations below grade or behind exterior trim and other conditions where water might enter the structure, as for exposed exterior work.
- I. Structural Connections and Fasteners: Include as required for complete fabrication and installation of the work; of materials, types and sizes adequate for the purposes.
 - 1. Place in concealed or obscured locations where possible.
 - 2. Include suitable welding or brazing where required.
- J. Powder Activated Fasteners: Limited to uses particularly shown, specified or approved by Architect. Operators shall be certified in accordance with California Industry Safety orders.
- K. Ferrous Work permanently exposed to exterior or below grade shall be galvanized; related accessory members and fastening non-ferrous, galvanized or made rustproof by approved methods.
- L. Galvanizing, prime painting and related touch-up and repair shall comply with requirements for metal fabricating and painting per project technical specifications.
- M. Isolation: Provide between ferrous and non-ferrous or dissimilar metal components to protect the work against electrolysis, as follows:
 - 1. For architectural work, provide cork fillers, asphaltic coatings, neoprene gaskets or similar separation as necessary; and use stainless steel fastenings only where interconnecting dissimilar parts.
 - 2. For mechanical and electrical work, provide dielectric unions or similar separation. In particular, provide isolation as necessary between exterior underground systems and interior above-grade systems where they meet dissimilar metals.
- N. Prior to starting a particular type or kind of work, examine for relevant information, all contract documents and subsequent data issued to the project.

1.10 DAMAGE AND RESTORATION

- A. Damage to previously existing or newly placed facilities caused by movement of equipment or other operations, whether accidental or made necessary by reason of Contract requirements, shall be restored or replaced as specified or directed by Architect or Construction Manager.

- B. Restoration shall be equal to the structural qualities or performance capacities of the original work, and finishes shall match the appearance of, as nearly as possible, like existing adjacent work. Restorations shall be subject to approval by Architect and shall be made as necessary at no added expense to Owner unless otherwise particularly provided for.
- C. Work not properly restored or where not capable of being restored as intended under these Specifications shall be removed and replaced as directed by Architect at no added expense to Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

- A. General: Comply with Section 017329 - CUTTING AND PATCHING.
- B. Employ skilled and experienced installer to perform cutting and patching.
- C. Submit written request in advance of cutting or altering elements, which affects:
 - 1. Structural integrity of element.
 - 2. Integrity of weather-exposed or moisture-resistant elements.
 - 3. Efficiency, maintenance, or safety of element.
 - 4. Visual qualities of sight-exposed elements.
- D. Execute cutting, fitting, and patching including excavation and fill, to complete Work, and to:
 - 1. Fit the several parts together, to integrate with other Work.
 - 2. Uncover Work to install or correct ill-timed work.
 - 3. Remove and replace defective and non-conforming Work.
 - 4. Remove samples of installed Work for testing.
 - 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- E. Execute work by methods, which will avoid damage to other Work, and provide proper surfaces to receive patching and finishing.
- F. Cut rigid materials using masonry saw or core drill.
- G. Restore Work with new products in accordance with requirements of Contract Document.
- H. Fit Work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- I. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- J. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.
- K. Identify any hazardous substance or condition exposed during the Work to the Construction Manager for decision or remedy.

END OF SECTION

SECTION 013119 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the required meetings for this work. These meetings include:
 - 1. Pre-construction Conference
 - 2. Scheduling Meetings
 - 3. Progress Meetings
 - 4. Special Meetings

- B. Related Sections
 - 1. Section 011100: Summary of Work
 - 2. Section 013200: Progress Schedules and Reports
 - 3. Section 013300: Submittals

1.2 PRECONSTRUCTION CONFERENCE

- A. Construction Manager will call for and administer Pre-construction Conference at time and place to be announced. Conference will occur as soon after award as can be reasonably scheduled.

- B. Contractor, all subcontractors, and major suppliers shall attend Pre-construction Conference.

- C. Agenda will include, but not be limited to, the following items:
 - 1. Schedules
 - 2. Personnel
 - 3. Use of the Site
 - 4. Temporary Utilities
 - 5. Location of Contractor's on-site facilities
 - 6. Project access
 - 7. Employee parking
 - 8. Security/Safety
 - 9. Housekeeping
 - 10. Submittals
 - 11. Inspection and testing procedures, on-site and off-site
 - 12. Utility shutdown procedures
 - 13. Control and reference point survey procedures
 - 14. Injury and Illness Prevention Program
 - 15. Contractor's Initial CPM Schedule
 - 16. Contractor Invoicing, Schedule of Values, Approval Procedures

- D. Construction Manager will distribute copies of minutes to attendees. Attendees shall have five (5) working days to submit comments or additions to minutes. Minutes will constitute final memorialization of results of the Pre-construction Conference.

1.3 SCHEDULING MEETINGS

- A. Meet with Construction Manager and Architect on Start Date of Contract and conduct initial review of Contractor's draft Shop Drawing and Sample Submittal Schedule, and draft Schedule of Values and Initial Construction Schedule ("Schedule Review Meeting").

- B. Authorized representative in Contractor's organization, designated in writing, who will be responsible for working and coordinating with Construction Manager's representative(s) and Architect relative to preparation and maintenance of Progress Schedule shall attend initial Schedule Review Meeting.

- C. Contractor shall, within thirty (30) days from the Notice to Proceed date, meet with Construction Manager and Architect to review the Original CPM Schedule submittal.
 - 1. Contractor shall have its manager, superintendent, scheduler, and key subcontractor representatives, as required by CLPCCD, in attendance. The meeting will take place over a continuous one-day period.
 - 2. CLPCCD's review of Schedule Submittals will be limited to conformance to Contract requirements, including, but not limited to, coordination requirements. However, review may also include:
 - a. Clarifications of Contract Requirements
 - b. Directions to include activities and information missing from submittal
 - c. Requests to Contractor to clarify its schedule
 - 3. Within five (5) days of the initial Schedule Review Meeting, Contractor shall respond in writing to all questions and comments expressed by CLPCCD at the meeting.
- D. Construction Manager will administer scheduling meetings and shall distribute minutes of scheduling meetings to attendees. Attendees shall have five (5) working days to submit comments or additions to minutes. Minutes will constitute final memorialization of results of the scheduling meetings.

1.4 PROGRESS MEETINGS

- A. Construction Manager and Architect will schedule and administer Progress Meetings throughout duration of Work. Progress meetings will be held weekly unless otherwise directed by Construction Manager.
 - 1. Meetings shall be held at Construction Manager's on-site office unless otherwise directed by Construction Manager.
 - 2. Construction Manager will prepare agenda and distribute to Contractor, Inspector and Architect/Engineer 24 hours in advance of meeting.
 - 3. Construction Manager will preside at meeting.
 - 4. Architect will record and distribute minutes to Contractor, Inspector, Construction Manager, all other participants, and those affected by decisions made at meeting, within three (3) working days after meeting. Attendees shall have five (5) working days to submit comments or additions to minutes. Minutes will constitute final memorialization of results of progress meetings.
- B. Progress Meetings shall be attended by Contractor's job superintendent, major subcontractors and suppliers, when requested by Construction Manager or as appropriate, Construction Manager, Architect/Engineer, Inspector and others as appropriate to agenda topics for each meeting.
- C. Agenda will contain the following items as appropriate:
 - 1. Review of work progress
 - 2. Status of Construction Schedule, adjustments
 - 3. Submittals
 - 4. Delivery schedules
 - 5. Utility shutdowns, traffic disruptions, and interferences with public scheduled during the subsequent 2 weeks
 - 6. Quality control
 - 7. Pending changes
 - 8. Substitutions
 - 9. Review of Contractor's safety program activities and results, including report on all serious injury and/or damage accidents
 - 10. Safety
 - 11. Other items affecting progress of work
- D. A separate meeting will be held on approximately the 25th of each month to review the schedule update submittal and progress payment application.
 - 1. At this meeting, at a minimum, the following items will be reviewed:
 - a. percent complete of each activity

- b. time impact evaluations for Change Orders and Time Extension Request
 - c. actual and anticipated activity sequence changes
 - d. actual and anticipated duration changes
 - e. actual and anticipated contractor delays
- 2. These meetings are considered a critical component of overall monthly schedule update submittal and Contractor shall have appropriate personnel attend. At a minimum, these meetings shall be attended by Contractor's General Superintendent and Scheduler.
 - 3. Contractor shall plan on progress meetings taking no less than four (4) hours.

1.5 SPECIAL MEETINGS

- A. Special meetings may be called by any party by notifying all desired participants, Construction Manager, Architect, and Inspector four (4) working days in advance, giving reason for meeting. Special Meetings may be held without advance notice in emergency situations.
- B. At any time during the progress of the Work, CLPCCD shall have authority to require Contractor to attend conference of any or all of the contractors engaged in the Work or in other work, and notice of such conference shall be duly observed and complied with by Contractor.
- C. Contractor shall schedule and conduct coordination meetings as necessary to discharge coordination responsibilities in the General Conditions. Construction Manager shall be given five (5) days written notice of coordination meetings. Contractors shall maintain minutes of coordination meetings. Attendees shall have five (5) working days to submit comments or additions to minutes. Minutes will constitute final memorialization of results of the meetings.
- D. Pre-installation meetings of manufactures' warranty scope of work, i.e., roofing, water-proofing, curtain wall, etc.
- E. LEED kick-off meeting.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not used)

END OF SECTION

SECTION 013200 - PROGRESS SCHEDULE AND REPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scheduling of Work under this Contract shall be performed by Contractor in accordance with requirements of this Section.
1. Development of schedule, cost and manpower loading of the schedule and schedule updates, monthly payment requests and project status reporting requirements of the Contract shall employ computerized Critical Path Method (CPM) scheduling.
 2. Submit schedules and reports as specified in General Conditions.
- B. Upon Award of Contract, Contractor shall immediately commence development of Initial and Original CPM Schedules to ensure compliance with CPM schedule submittal requirements.
- C. Related Sections:
1. Section 011100: Summary of Work
 2. Section 013300: Submittal Procedures
- D. Definitions: The following definitions apply to this section:
1. **ACTIVITY:** A task, event or other project element on a schedule that contributes to completing the project. Activities have a description, start date, finish date, duration and one or more logic ties.
 2. **BASELINE SCHEDULE:** The initial schedule representing the Contractor's work plan on the first day of the project.
 3. **CRITICAL PATH:** The longest continuous chain of activities for the project that has the least amount of total float of all chains. In general, a delay on the critical path will extend the scheduled completion date.
 4. **CRITICAL PATH METHOD (CPM):** A network based planning technique using activity durations and the relationships between activities to mathematically calculate a schedule for the entire project.
 5. **DATA DATE:** The day after the date through which a schedule is current. Everything occurring earlier than the data date is "as-built" and everything on or after the data date is "planned".
 6. **EARLY COMPLETION TIME:** The difference in time between an early scheduled completion date and the contract completion date.
 7. **FLOAT:** The difference between the earliest and latest start or finish times for an activity.
 8. **MILESTONE:** An event activity that has zero duration and is typically used to represent the beginning or end of a certain stage of the project.
 9. **NARRATIVE REPORT:** A document submitted with each schedule that discusses topics related to project progress and scheduling.
 10. **NEAR CRITICAL PATH:** A chain of activities with total float exceeding that of the critical path but having no more than 14 calendar days of total float.
 11. **SCHEDULED COMPLETION DATE:** The planned project finish date shown on the current accepted schedule.
 12. **SUBSTANTIAL COMPLETION:** The stage in the progress of the work when the work is complete in accordance with the Contract Documents, so that District can occupy or use the work for its intended purpose.
 13. **TIME IMPACT ANALYSIS:** A schedule and narrative report developed specifically to demonstrate what effect a proposed change or delay has on the current scheduled completion date.
 14. **TIME-SCALED NETWORK DIAGRAM:** A graphic depiction of a CPM schedule comprised of activity bars with relationships for each activity represented by arrows. The tail of each arrow connects to the activity bar for the predecessor and points to the successor.
 15. **TOTAL FLOAT:** The amount of time that an activity or chain of activities can be delayed before extending the scheduled completion date.

16. **UPDATED SCHEDULE:** A current schedule developed from the baseline or subsequent schedule through regular monthly review to incorporate as-built progress and any planned changes.

1.2 QUALIFICATIONS

- A. Contractor shall employ experienced scheduling personnel qualified to use the latest version of Primavera Project Planner or Microsoft Project scheduling software. Experience level required is set forth below. Contractor may employ such personnel directly or may employ a consultant for this purpose. After bid opening, the apparent successful low bidder shall provide District a written verification that Contractor has the required personnel under its employ or that Contractor will employ the required CPM scheduling consultant.
 1. The written statement shall identify individual who will perform CPM scheduling.
 2. Capability and experience shall be verified by description of construction projects on which individual has successfully applied computerized CPM.
 3. Required level of experience shall include at least two projects of similar nature, scope and value not less than three-fourths the Total Bid Price of this Project. The written statement shall provide contact persons for referenced projects with current telephone and address information.
- B. District reserves right to approve Contractor's scheduler, or consultant, and right to reject them at any time. District also reserves right to refuse replacement of Contractor's scheduler or consultant, if it believes such replacement will negatively affect Contract.

1.3 GENERAL

- A. Progress Schedule shall be based on and incorporate milestones and completion dates specified in Contract Documents. Submit to the Owner baseline, monthly updated, and final updated schedules, each consistent in all respects with the time and order of work requirements of the contract. Work must be executed in the sequence indicated on the current accepted schedule. Schedules must show the order in which you propose to execute the work with logical links between time-scaled work activities and calculations made using the critical path method to determine the controlling activities. You are responsible for assuring that all activity sequences are logical and that each schedule shows a coordinated plan for complete performance of the work.
- B. Overall time of completion and time of completion for each milestone shown on Progress Schedule shall adhere to times as stated in Contract Agreement, unless an earlier (advanced) time of completion is requested by Contractor and agreed to by District. Any such agreement shall be formalized by a Change Order.
 1. District is not required to accept an earlier (advanced) schedule, i.e., one that shows early completion dates for the Contract Times.
 2. Contractor shall not be entitled to extra compensation in the event agreement is reached on an earlier (advanced) schedule and Contractor completes its Work, for whatever reason (excepting approved changes with added time components) beyond completion date shown in earlier (advanced) schedule but within the Contract Times.
 3. A schedule showing the work completed in less than the Contract Times, which has been accepted by District, shall be considered to have Project Float. The Project Float is the time between the scheduled completion of the work and Contract Substantial Completion. Project Float is a resource available to both District and the Contractor.
- C. Float Ownership: Neither District nor Contractor owns float. The Project owns the float. As such, liability for delay of the Substantial Completion Date rests with the party whose actions, last in time, actually cause delay to the Substantial Completion Date.
 1. For example, if Party A uses some, but not all of the float and Party B later uses remainder of the float as well as additional time beyond the float, Party B shall be liable for the time that represents a delay to the Substantial Completion Date.
 2. Party A would not be responsible for the time since it did not consume the entire float and additional float remained; therefore, the Substantial Completion Date was unaffected.

- D. Progress Schedule shall be the basis for evaluating job progress, payment requests, and time extension requests associated with the changes. Responsibility for developing Contract CPM schedule and monitoring actual progress as compared to Progress Schedule rests with Contractor.
- E. The Owner's review and acceptance of schedules does not waive any contract requirements and does not relieve Contractor of any obligation or responsibility for submitting complete and accurate information. Correct rejected schedules and resubmit corrected schedules to the Owner within seven (7) days of notification by the Owner, at which time a new review period of seven (7) days will begin.
- F. Errors or omissions on schedules do not relieve Contractor from finishing all work within the time limit specified for completion of the contract. If, after a schedule has been accepted by the Owner, either the Contractor or the Owner discovers that any aspect of the schedule has an error or omission, it must be corrected on the next updated schedule.
- G. Use Microsoft Project for Windows or Primavera P6. Such software shall be compatible with Windows operating system. Contractor shall transmit contract schedule files to District on CD-ROM or flash drive at times requested by District.
- H. Transmit each item under form approved by District.
 - 1. Identify Project with District Contract number and name of Contractor and file by date, project, and update number.
 - 2. Provide space for Contractor's approval stamp and District's review stamps.
 - 3. Submittals received from sources other than Contractor will be returned to the Contractor without District's review.

1.4 INITIAL CRITICAL PATH METHOD (CPM) SCHEDULE

- A. Initial CPM Schedule submitted for review at the pre-construction conference shall serve as Contractor's schedule for up to ninety (90) calendar days after the Notice to Proceed.
- B. Indicate detailed plan for the Work to be completed in first sixty (60) days of the Contract; details of planned mobilization of plant and equipment; sequence of early operations; and procurement of materials and equipment. Show Work beyond sixty (60) calendar days in summary form.
- C. Initial CPM Schedule shall be time-scaled.
- D. Initial CPM Schedule shall be cost and manpower loaded. Accepted cost and manpower-loaded schedule will be used as basis for monthly progress payments until acceptance of the Original CPM Schedule. Use of Initial CPM Schedule for progress payments shall not exceed sixty (60) calendar days.
- E. District and Contractor shall meet to review and discuss the Initial CPM Schedule within seven (7) calendar days after it has been submitted to District.
 - 1. District's review and comment on the schedule shall be limited to Contract conformance (with sequencing, coordination, and milestone requirements) and accepted CPM principals.
 - 2. Contractor shall make corrections to schedule necessary to comply with Contract requirements and shall adjust schedule to incorporate any missing information requested by District. Contractor shall resubmit Initial CPM Schedule if requested by District.
- F. If, during the first sixty (60) days after Notice-to-Proceed, the Contractor is of the opinion that any of the Work included on its Initial CPM Schedule has been impacted, the Contractor shall submit to District a written Time Impact Evaluation (TIE) in accordance with Article 1.09 of this Section. The TIE shall be based on the most current update of the Initial CPM Schedule.

1.5 ORIGINAL CRITICAL PATH METHOD (CPM) SCHEDULE

- A. Submit a detailed proposed Original CPM Schedule presenting an orderly and realistic plan for completion of the Work, in conformance with requirements as specified herein.
- B. The baseline schedule must not extend beyond the number of contract days. The baseline schedule must have a data date of the first working day of the contract and not include any completed work to date. The baseline schedule must not attribute negative float or negative lag to any activity.
- C. Progress Schedule shall include or comply with following requirements:
1. Time scaled, cost and manpower loaded CPM schedule.
 2. No activity on schedule shall have duration longer than twenty-one (21) calendar days, with exception of submittal, approval, fabrication and procurement activities, unless otherwise approved by District.
 - a. Activity durations shall be total number of actual days required to perform that activity.
 - b. Activity coding capabilities to sort by responsibility, location, phase and CSI division.
 3. The start and completion dates of all items of Work, their major components, and milestone completion dates, if any.
 4. District-furnished materials and equipment, if any, identified as separate activities.
 5. Completion of the last activity in the schedule shall be constrained by the contract completion date. Schedule calculations shall result in a negative float when the calculated early finish date of the last activity is later than the contract completion date. The Contractor shall include as the last activity in the project schedule an activity called "Final Completion". The "Final Completion" activity shall have an "LF" constraint date equal to the contract completion date for the project, and with a zero day duration or by using the "project must finish by" date in the scheduling software. The schedule shall have no constrained dates other than those specified in the contract. The use of artificial float constraints such as "zero free float" or "zero total float" are typically prohibited. There shall only be two (2) open ended activities: Start Project (or NTP) with no predecessor logic and Final Completion with no successor logic.
 6. Processing/approval of submittals and shop drawings for all Contract-required material and equipment. Activities that are dependent on submittal acceptance or material delivery shall not be scheduled to start earlier than expected acceptance or delivery dates.
 - a. Include time for submittals, resubmittals, and reviews by District. Coordinate with accepted schedule for submission of shop drawings, samples and other submittals.
 - b. Contractor shall be responsible for all impacts resulting from resubmittal of shop drawings and submittals.
 7. Procurement of all contract required material and equipment, identified as separate activity.
 - a. Include time for fabrication and delivery of manufactured products for the Work.
 - b. Show dependencies between procurement and construction.
 8. Complete activity description; what Work is to be accomplished and where.
 9. The total cost of performing each activity shall be total of labor, material, equipment, excluding overhead and profit of Contractor. Total overhead and profit of the General Contractor shall be shown on a separate activity in the schedule. Sum of cost for all activities shall equal total Contract value.
 10. Resources required (labor) to perform each activity.
 11. Responsibility code for each activity corresponding to Contractor or Subcontractor responsible for performing the Work.
 12. Identify the activities, which constitute the controlling operations or critical path. No more than twenty-five (25%) of the activities shall be critical or near critical. Near critical is defined as float in the range of one (1) to ten (10) days.
 13. At least twenty-eight (28) calendar days for developing punch list(s), completion of punch list items and final clean-up for the Work or any designated portion thereof. No other activities shall be scheduled during this period.

14. Interface with the work of other contractors, District, and agencies such as, but not limited to, utility companies.
 15. Show detailed Subcontractor Work activities. In addition, furnish copies of Subcontractor schedules upon which CPM was built.
 - a. Also furnish for each Subcontractor, as determined by District, submitted on Subcontractor letterhead a statement certifying that Subcontractor concurs with Contractor's Original CPM Schedule and that Subcontractor's related schedules have been incorporated, including activity duration, cost and resource loading.
 - b. Subcontractor schedules shall be independently derived and not a copy of Contractor's schedule.
 - c. In addition to Contractor's schedule and resource loading, obtain from electrical, mechanical and plumbing Subcontractors, and other Subcontractors as required by District, productivity calculations common to their trades, such as units per person day, feet of pipe per day per person, feet of wiring per day per person, and similar information.
 - d. Furnish schedule for Contractor/Subcontractor CPM Schedule meetings which shall be held prior to submission of Original CPM Schedule to District. District shall be permitted to attend scheduled meetings as an observer.
 16. Activity durations shall be in calendar days.
 17. Submit with the schedule a list of anticipated non-Work days, such as weekends and holidays.
- D. Original CPM Schedule Review Meeting: Contractor shall, within thirty (30) calendar days from the Notice to Proceed date, meet with District to review the Original CPM Schedule submittal.
1. Contractor shall have its Construction Manager, Project Superintendent, Project Scheduler, and key Subcontractor representatives, as required by District, in attendance. The meeting will take place over a continuous one-day period.
 2. District's review will be limited to submittal's conformance to Contract requirements, including, but not limited to, coordination requirements. However, review may also include:
 - a. Accepted critical path method principles and tenets.
 - b. Clarifications of Contract Requirements.
 - c. Directions to include activities and information missing from submittal.
 - d. Requests to Contractor to clarify its schedule.
 3. Within five (5) days of the Schedule Review Meeting, Contractor shall respond in writing to all questions and comments expressed by District at the Meeting.

1.6 ADJUSTMENTS TO CRITICAL PATH METHOD (CPM) SCHEDULE

- A. Adjustments to Original CPM Schedule: Contractor shall have adjusted the Original CPM Schedule submittal to address all review comments from original CPM Schedule review meeting and resubmit network diagrams and reports for District's review.
1. District, within fourteen (14) days from date that Contractor submitted the revised schedule, will either:
 - a. accept schedule and cost and resource loaded activities as submitted, or
 - b. advise Contractor in writing to review any part or parts of schedule which either do not meet Contract requirements or are unsatisfactory for District to monitor Project's progress, resources and status or evaluate monthly payment request by Contractor.
 2. District may accept schedule with conditions that the first monthly CPM schedule update be revised to correct deficiencies identified.
 3. When schedule is accepted, it shall be considered as the "Original CPM Schedule" which will then be immediately updated to reflect the current status of the work.
 4. District reserves the right to require Contractor to adjust, add to, or clarify any portion of schedule which may later be discovered to be insufficient for monitoring of Work or approval of partial payment requests. No additional compensation will be provided for such adjustments, additions, or clarifications.

- B. Acceptance of Contractor's schedule by District will be based upon schedule's compliance with Contract requirements and accepted CPM principles.
 - 1. By way of Contractor assigning activity durations and proposing sequence of Work, Contractor agrees to utilize sufficient and necessary management and other resources to perform work in accordance with the schedule.
 - 2. Upon submittal of schedule update, updated schedule shall be considered "current" CPM schedule.
 - 3. Submission of Contractor's schedule to District shall not relieve Contractor of total responsibility for scheduling, sequencing, and pursuing Work to comply with requirements of Contract Documents, including adverse effects such as delays resulting from ill-timed work.
- C. Submittal of Original CPM Schedule, and subsequent schedule updates, shall be understood to be Contractor's representation that the Schedule meets requirements of Contract Documents and that Work shall be executed in sequence indicated on the schedule.
- D. Contractor shall distribute Original CPM Schedule to Subcontractors for review and written acceptance, which shall be noted on Subcontractors' letterhead to Contractor and transmitted to District for the record.

1.7 MONTHLY CPM SCHEDULE UPDATE SUBMITTALS

- A. Following acceptance of Contractor's Original CPM Schedule, Contractor shall monitor progress of Work and adjust schedule each month to reflect actual progress and any pre-approved changes to planned activities or logic.
 - 1. Each schedule update submitted shall be complete, including all information requested for the Original CPM Schedule submittal.
 - 2. Each update shall continue to show all work activities including those already completed. These completed activities shall accurately reflect "as built" information by indicating when activities were actually started and completed.
- B. A meeting will be held on approximately the twenty-fifth (25th) of each month to review the schedule update submittal and progress payment application.
 - 1. At this meeting, at a minimum, the following items will be reviewed: Percent complete of each activity; time impact evaluations for Change Orders and Time Extension Request; anticipated activity sequence changes; anticipated duration changes; actual and anticipated contractor delays.
 - 2. These meetings are considered a critical component of overall monthly schedule update submittal and Contractor shall have appropriate personnel attend. At a minimum, these meetings shall be attended by Contractor's General Superintendent and Scheduler.
 - 3. Contractor shall plan on the meeting taking no less than four (4) hours.
- C. Within seven (7) calendar days after monthly schedule update meeting, Contractor shall submit the updated CPM Schedule update.
- D. Within seven (7) calendar days of receipt of above noted revised submittals, District will either accept or reject monthly schedule update submittal.
 - 1. If accepted, percent complete shown in monthly update will be basis for Application for Payment by the Contractor. The schedule update shall be submitted as part of the Contractor's Application for Payment.
 - 2. If rejected, update shall be corrected and resubmitted by Contractor before the Application for Payment is submitted.
- E. Updating, changing or revising of any report, curve, schedule or narrative submitted to District by Contractor under this Contract, nor District's review or acceptance of any such report, curve, schedule or narrative shall not have the effect of amending or modifying, in any way, the Contract Substantial Completion date or milestone dates or of modifying or limiting, in any way, Contractor's obligations under this Contract.

- F. Final Updated Schedule. Submit final updated, as-built schedule with actual start and finish dates for the activities, within 30 days after completion of contract work. Provide a written certificate with this submittal signed by your Project Manager or an officer of the company stating, "To my knowledge and belief, the enclosed final update schedule reflects that actual start date and finish dates of the actual activities for the project contained herein". An officer of the company may delegate in writing the authority to sign the certificate to a responsible manager.

1.8 SCHEDULE REVISIONS

- A. Updating the Schedule to reflect actual progress shall not be considered revisions to the Schedule. Since scheduling is a dynamic process, revisions to activity durations and sequences are expected on a monthly basis.
- B. To reflect revisions to the schedule, the Contractor shall provide District with a written narrative with a full description and reasons for each Work activity revised. For revisions affecting the sequence of work, the Contractor shall provide a schedule diagram which compares the original sequence to the revised sequence of work. The Contractor shall provide the written narrative and schedule diagram for revisions two (2) working days in advance of the monthly schedule update meeting.
- C. Schedule revisions shall not be incorporated into any schedule update until the revisions have been reviewed by District. District may request further information and justification for schedule revisions and Contractor shall, within three (3) days, provide District with a complete written narrative response to District's request.
- D. If the Contractor's revision is still not accepted by District, and the Contractor disagrees with District's position, the Contractor has seven (7) calendar days from receipt of District's letter rejecting the revision, to provide a written narrative providing full justification and explanation for the revision. The Contractor's failure to respond in writing within seven (7) calendar days of District's written rejection of a schedule revision shall be contractually interpreted as acceptance of District's position, and the Contractor waives its rights to subsequently dispute or file a claim regarding District's position.
- E. At District's discretion, the Contractor can be required to provide subcontractor certifications of performance regarding proposed schedule revisions affecting said subcontractors.

1.9 RECOVERY SCHEDULE

- A. If the Schedule Update shows a substantial completion date fourteen (14) calendar days beyond the Contract Substantial Completion date, or individual milestone completion dates, the Contractor shall submit to District the proposed revisions to recover the lost time within seven (7) calendar days. As part of this submittal, the Contractor shall provide a written narrative for each revision made to recapture the lost time. If the revisions include sequence changes, the Contractor shall provide a schedule diagram comparing the original sequence to the revised sequence of work.
- B. The revisions shall not be incorporated into any schedule update until the revisions have been reviewed by District.
- C. If the Contractor's revisions are not accepted by District, District and the Contractor shall follow the procedures in paragraph 1.08.C, 1.08.D and 1.08.E above.
- D. At District's discretion, the Contractor can be required to provide subcontractor certifications for revisions affecting said subcontractors.

1.10 TIME IMPACTS EVALUATION (TIE) FOR CHANGE ORDERS, AND OTHER DELAYS

- A. Time Impact Analysis (TIA). Submit a written TIA to the Owner with each request for adjustment of contract time, or when the Contractor or the Owner considers that an approved or anticipated change may impact the critical path or contract progress.

- B. The TIA must illustrate the impacts of each change or delay on the current scheduled completion date or internal milestone, as appropriate. The analysis must use the accepted schedule that has a data date closest to and before the event. If the Owner determines that the accepted schedule used does not appropriately represent the conditions before the event, the accepted schedule must be updated to the day before the event being analyzed. The TIA must include an impact schedule developed from incorporating the event into the accepted schedule by adding or deleting activities, or by changing durations or logic of existing activities. If the impact schedule shows that incorporating the event modifies the critical path and scheduled completion date of the accepted schedule, the difference between scheduled completion dates of the two schedules must be equal to the adjustment of contract time. The Owner may construct and use an appropriate project schedule or other recognized method to determine adjustments in contract time until the Contractor provide the TIA.
- C. Contractor shall be required to comply with the requirements of Paragraph 1.09.A for all types of delays such as, but not limited to, Contractor/Subcontractor delays, adverse weather delays, strikes, procurement delays, fabrication delays, etc.
- D. Contractor shall be responsible for all costs associated with the preparation of Time Impact Analysis, and the process of incorporating them into the current schedule update. The Contractor shall provide District with 4 copies of each TIA.
- E. Once agreement has been reached on a TIA, the Contract Times will be adjusted accordingly. If agreement is not reached on a TIA, the Contract Times may be extended in an amount District allows, and the Contractor may submit a claim for additional time claimed by Contractor.

1.11 TIME EXTENSIONS

- A. The Contractor is responsible for requesting time extensions for time impacts that, in the opinion of the Contractor, impact the critical path of the current schedule update. Notice of time impacts shall be given in accord with Articles 1.12 and 1.15 of Contract Document General Conditions.
- B. Where an event for which District is responsible impacts the projected Substantial Completion date, the Contractor shall provide a written mitigation plan, including a schedule diagram, which explains how (e.g., increase crew size, overtime, etc.) the impact can be mitigated. The Contractor shall also include a detailed cost breakdown of the labor; equipment and material the Contractor would expend to mitigate District caused time impact. The Contractor shall submit its mitigation plan to District within fourteen (14) calendar days from the date of discovery of said impact. The Contractor is responsible for the cost to prepare the mitigation plan.
- C. Failure to request time, provides TIA, or provides the required mitigation plan will result in Contractor waiving its right to a time extension and cost to mitigate the delay.
- D. No time will be granted under this Contract for cumulative effect of changes.
- E. District will not be obligated to consider any time extension request unless requirements of Contract Documents are complied with.
- F. Failure of the Contractor to perform in accordance with the current schedule update shall not be excused by submittal of time extension requests.
- G. If the Contractor does not submit a TIA within the required fourteen (14) calendar days for any issue, it is mutually agreed that the Contractor does not require a time extension for said issue.

1.12 SCHEDULE REPORTS

- A. Submit four (4) copies of the following reports with the Initial CPM Schedule, the Original CPM Schedule, and each monthly update.

B. Required Reports:

1. Two (2) activity-listing reports: one sorted by activity number and one by total float. These reports shall also include each activity's early/late and actual start and finish dates, original and remaining duration, float, responsibility code and the logic relationship of activities.
2. Cost report sorted by activity number including each activity's associated cost, percentage of Work accomplished, earned value to-date, previous payments and amount earned for current update period.
3. Schedule plots presenting time scaled network diagram showing activities and their relationships with the controlling operations or critical path clearly highlighted.
4. Cash flow report calculated by early start, late start and indicating actual progress. Provide an exhibit depicting this information in graphic form.

- C. Furnish District with report files in CD ROM and containing all Microsoft Project .mpp or Primavera .xer schedule files along with report files.

1.13 PROJECT STATUS REPORTING

- A. In addition to submittal requirements for CPM scheduling identified in this Section, Contractor shall provide a monthly project status report (i.e., written narrative report) to be submitted in conjunction with each CPM Schedule as specified herein. Status reporting shall be in form specified below.

- B. Contractor shall prepare monthly written narrative reports of status of Project for submission to District. Written status reports shall include:

1. Transmittal letter
2. Work completed during the period, percent complete of activities
3. Identification of unusual conditions or restrictions regarding labor, equipment or material: including multiple shifts, 6-day work weeks, specified overtime or work at times other than regular days or hours
4. Description of the current critical path
5. Changes to the critical path and scheduled completion date since the last schedule submittal
6. Description of problem areas
7. Current and anticipated delays:
 - a. Cause of delay
 - b. Impact of delay on other activities, milestones and completion dates
 - c. Corrective action and schedule adjustments to correct the delay
8. Contractor may include any other information pertinent to status of Project. Contractor shall include additional status information requested by District at no additional cost.
9. Status reports, and the information contained therein, shall not be construed by the
10. Contractor as claims, notice of claims, notice of delay, or requests for changes or compensation.

1.14 WEEKLY SCHEDULE REPORT

- A. At the Weekly Progress Meeting, the Contractor shall provide and present a time scaled four (4) week schedule one (1) week behind and three (3) week look ahead schedule that is based and correlated by activity number to the current schedule (i.e., Initial, Original CPM, or Schedule Update).

1.15 DAILY CONSTRUCTION REPORTS

- A. On a daily basis, Contractor shall submit a daily activity report to District for each workday, including weekends and holidays, when worked. Contractor shall develop the daily construction reports on a computer generated database capable of sorting daily Work, manpower and man-hours by Contractor, Subcontractor, area, sub area, and change order work. Upon request of District, furnish computer disk of this database. Obtain District's written approval of daily construction report database format prior to implementation. Include in report:

1. Project name and Project number.
2. Contractor's name and address.
3. Weather, temperature and any unusual site conditions.
4. Brief description and location of the day's scheduled activities and any special problems and accidents, including Work of Subcontractors. Descriptions shall be referenced to CPM scheduled activities.
5. Worker quantities for its own Work force and for Subcontractors of any tier.
6. Equipment, other than hand tools, utilized by Contractor and Subcontractors.

1.16 PERIODIC VERIFIED REPORTS

- A. The Contractor shall complete and submit the Final Verified Report required by DSA. In addition to other conditions precedent to Final Payment, the Contractor's completion and submission of the Final Verified Report is an express condition precedent to the District's obligation to make the Final Payment. In addition to completion and submission of the Final Verified Report, as a material obligation under the Contract Documents, the Contractor shall comply all DSA requests for reports or other data relating to the Work, the status thereof or conformity of the Work to the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Periodic construction photographs.
 - 4. Final Completion construction photographs.

- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 2. Section 024100 "General Demolition Procedures" for photographic documentation before building demolition operations commence.

1.2 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos on CD-ROM or thumb-drive. Include copy of key plan indicating each photograph's location and direction.
 - 2. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of location, vantage point, and direction.
 - g. Unique sequential identifier keyed to accompanying key plan.

- C. Video Recordings: Submit video recordings within seven days of recording.
 - 1. Submit video recordings on CD-ROM or thumb drive. Include copy of key plan indicating each video's location and direction.
 - 2. Identification: With each submittal, provide the following information in file metadata tag:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date video recording was recorded.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - 3. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in three-ring binders. Provide label on front and spine. Include a cover sheet with label information. Include name of Project and date of video recording on each page.

1.3 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.4 FORMATS AND MEDIA

- A. General: Provide either photographs or video recordings, or a combination of both, to document conditions prior to and during demolition, construction, and closout as indicated.
- B. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.
- C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- D. File Names: Name media files with Project area and sequential numbering suffix.

1.5 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs with maximum depth of field and in focus.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag excavation areas before taking construction photographs.
 - 2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take 20 photographs of existing buildings either on or adjoining property, to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- C. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:
 - 1. Underground utilities.
 - 2. Underslab services.
 - 3. Piping.
 - 4. Electrical conduit.
 - 5. Waterproofing and weather-resistant barriers.
- D. Periodic Construction Photographs: Take 20 photographs monthly coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- E. Final Completion Construction Photographs: Take 20 photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.
- F. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days' notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.

3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs shall be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals including:
 - 1. Procedures
 - 2. Schedule of Shop Drawing and Sample Submittals
 - 3. Safety Plan
 - 4. Progress Schedule
 - 5. Product Data
 - 6. Shop Drawings
 - 7. Samples
 - 8. Quality Control Submittals
 - 9. Design Data
 - 10. Test Reports
 - 11. Certificates
 - 12. Manufacturers' Instructions
 - 13. Machine Inventory Sheets Operations and Maintenance Manuals Computer Programs
 - 14. Project Record Documents
 - 15. LEED Submittals

1.2 RELATED SECTIONS

- A. Section 011100: Summary of Work.
- B. Section 012600: Contract Modification Procedures.
- C. Section 013200: "Progress Schedules and Reports" for submitting schedules and reports, including Contractor's Construction Schedule and the Submittals Schedule.
- D. Section 017000: Contract Closeout
- E. Section 017800: Project Record Documents.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Architect's responsive action.
- B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.4 SUBMITTAL PROCEDURES

- A. General: Electronic copies of CAD Drawings of the Contract Drawings are always through Architect for Contractor's use in preparing submittals. Files are used as background use only.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

- a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. **Submittals Schedule:** Comply with requirements in Division 1 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- D. **Processing Time:** Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Construction Manager's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. **Initial Review:** Allow 15 work days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Construction Manager will advise Contractor when a submittal being processed must be delayed for coordination.
 2. **When a large volume of submittal materials is scheduled, additional review time may be required. Similarly, a particular submittal may require review completion in less than the agreed normal time. Due to variations in submittal volume and processing needs, agreed review time is not intended to apply to extreme conditions.**
 3. **Resubmittal Review:** Allow 10 business days for review of each resubmittal.
 4. **Sequential Review:** Where sequential review of submittals by Architect's consultants, District, or other parties is indicated, allow 21 days for initial review of each submittal.
- E. Submit at own expense, a minimum of two (2) printed sets or copies and one (1) electronic PDF set- Schedule of Shop Drawing and Sample Submittals, Safety Plans, Progress Schedule, Product Data, Shop Drawings, Samples, Quality Control Data, Machine Inventory Sheets, Operations and Maintenance Manuals, Computer Programs, and Project Record Documents required by the Contract Documents.
- F. Transmit each item with a standard letter of transmittal in form approved by Construction Manager.
- G. Identify project, Contractor, subcontractor, major supplier, pertinent drawing sheet and detail number, and specification section number as appropriate. Provide space for Contractor, Construction Manager and Architect/Engineer review stamps.
- H. Where manufacturer's standard drawings or data sheets are used, they shall be marked clearly to show those portions of the data, which are applicable to this project.
- I. Submit Shop Drawings, Samples and other submittals to Construction Manager for review and approval by Architect/Engineer in accordance with accepted schedule of Shop Drawings and Samples submittals. If no such schedule is agreed upon, then all Shop Drawing, Samples and product data submittals shall be completed within ninety (90) days after receipt of Notice to Proceed from District.
- J. The data shown on the Shop Drawings shall be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to show Architect/Engineer the materials and equipment Contractor proposes to provide and to enable Architect/Engineer to review the information for the limited purposes specified below. Samples shall be identified clearly as to material, supplier, pertinent data such as catalog numbers and the use for which it is intended and otherwise as Architect/Engineer may require enabling Architect/Engineer to review the submittal. The number of each Sample to be submitted will be as specified in the Specifications.
- K. At the time of each submission, Contractor shall give Construction Manager, Architect/Engineer, and Inspector specific written notice of all variations, if any; that the Shop Drawing or Sample submitted may have from the requirements of the Contract Documents, and the reasons therefore. This written notice shall be in a written communication separate from the submittal. In addition, Contractor shall cause a specific notation to be made on each Shop Drawing and Sample submitted to Construction Manager for review and approval of each such variation by Architect/Engineer. The Architect/Engineer may make adjustments to submittals that may result in changes to the contract. The appropriate change order request should be prepared by the Contractor within ten (10) days of receipt of submittals.

- L. If District accepts deviation, District shall issue appropriate Contract Modification.
- M. Submittal coordination and verification is responsibility of Contractor; this responsibility shall not be delegated in whole or in part to subcontractors or suppliers. Before submitting each Shop Drawing or Sample, Contractor shall have determined and verified:
 - 1. All field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar information with respect thereto;
 - 2. All materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the Work; and
 - 3. All information relative to Contractor's sole responsibilities and of means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto.
- N. Contractor shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.
- O. Contractor's submission to Construction Manager of a Shop Drawing or Sample submittal will constitute Contractor's representation that it has satisfied its obligations under the Contract Documents, and as set forth immediately above, with respect to Contractor's review and approval of that submittal.
- P. Designation of work "by others", if shown in submittals, shall mean that work will be responsibility of Contractor rather than subcontractor or supplier who has prepared submittals.
- Q. After review by Architect/Engineer of each of Contractor's submittals, one electronic set will be returned to Contractor with actions defined as indicated below.
- R. The Final Review Code on the Submittal Review Sheet prevails and governs the action of the overall submittal.
- S. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect and Construction Manager.
- T. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned without review.
- U. Architect and Construction Manager will return without review or will discard submittals received from sources other than the Contractor.
- V. Submittals not required by the Contract Documents may be returned by the Architect without action.
- W. It is considered reasonable that Contractor shall make a complete and acceptable submittal at least by second submission.
 - 1. District reserves the right to deduct monies from payments due Contractor to cover additional costs of Architect's/Engineer's review beyond the second submission. Illegible submittals will be rejected and returned to Contractor for resubmission.

- X. Favorable review will not constitute acceptance by District or Architect/Engineer of any responsibility for the accuracy, coordination and completeness of the submittals. Accuracy, coordination, and completeness of Submittals shall be sole responsibility of Contractor, including responsibility to back check comments, corrections, and modifications from District's or Architect's/Engineer's review before fabrications. Submittals may be prepared by Contractor, subcontractors, or suppliers, but Contractor shall ascertain that submittals meet requirements of Contract Documents, while conforming to structural space and access conditions at point of installation. Architect/Engineer's review will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Favorable review of submittal, method of work, or information regarding materials and equipment Contractor proposes to furnish shall not relieve Contractor of responsibility for errors therein and shall not be regarded as assumption of risks or liability by Architect/Engineer or District, or any officer or employee thereof, and Contractor shall have no claim under Contract on account of failure or partial failure or inefficiency or insufficiency of any plan or method of work or material and equipment so accepted. Favorable review shall be considered to mean merely that Architect/Engineer or District has no objection to Contractor using, upon his own full responsibility, plan or method of work proposed, or furnishing materials and equipment proposed.
- Y. Architect's/Engineer's review will not extend the means, methods, techniques, sequences or procedures of construction or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
- Z. Submit complete initial submittal for those items where required by individual specification Sections. Complete submittal shall contain sufficient data to demonstrate that items comply with Specifications, shall meet minimum requirements for submissions cited in technical specifications, shall include motor data and seismic anchorage certifications, where required, and shall include necessary revisions required for equipment other than first named. If Contractor submits incomplete initial submittal, when complete submittal is required, submittal may be returned to Contractor without review.
- AA. It shall be Contractor's responsibility to copy, conform and distribute reviewed submittals in sufficient numbers for Contractor's files, subcontractors and vendors.
- BB. After Architect/Engineer review of submittal, revise and resubmit as required. Identify changes made since previous submittal.
 - 1. Begin no fabrication or work, which require submittals until return of submittals not requiring resubmittal.
 - 2. Normally, submittals will be processed and returned to Construction Manager within fifteen (15) working days of receipt by Architect. The processing time spent to review submittals by Construction Manager shall be in addition to the fifteen (15) days.
 - 3. Distribute copies of reviewed submittals to concerned persons. Instruct recipients to promptly report any inability to comply with provisions.

1.5 SCHEDULE OF SHOP DRAWING, DSA DEFERRED APPROVAL SUBMITTALS AND SAMPLE SUBMITTALS

- A. Submit preliminary Schedule of Shop Drawing and Sample Submittals as required by General Conditions. Submit two (2) copies and one (1) electronic PDF of final and accepted schedule of submittals of shop drawings and samples as required by General Conditions, and in no event later than thirty (30) days following Notice of Award.
- B. Schedule of Shop Drawing and Sample Submittals will be used by Architect/Engineer to schedule their activities relating to review of submittals. Schedule of submittals shall indicate a spreading out of submittals and early submittals of long lead-time items and of items, which require extensive review.
- C. Schedule of Shop Drawing and Sample Submittals shall be reviewed by Construction Manager and shall be revised and resubmitted until accepted by Construction Manager.

- D. DSA Deferred Approval Submittals shall be prepared for review by the Architect/Engineer within 30 days of receipt of Notice to Proceed. Contractor shall promptly make corrections to documents for Architect to submit to DSA for approval. Contractor shall have the sole responsibility for obtaining DSA approval via the Architect's office for all deferred approval submittals in a timely manner. There will be no time extensions granted for delay in obtaining such approval.

1.6 SAFETY PLAN

- A. Submit one (1) copies and one (1) electronic PDF of Safety Plan specific to this Contract to Construction Manager within fifteen (15) calendar days after Start Date of the Contract Time.
- B. No on-site work shall be started until Safety Plan has been reviewed and accepted by District. Acceptance of Safety Plan shall not affect Contractor's responsibility for maintaining a safe working place and instituting safety programs in connection with project in full compliance with local, state and federal regulations.

1.7 PROGRESS SCHEDULE

- A. Schedule all items requiring Architect action for submission during first 25 percent of construction period.
- B. See Section 013200 "Progress Schedules and Reports" for schedule and report requirements.
- C. Submit (3) print copies, one (1) electronic report file in PDF format, and either Microsoft Project .mpp or Primavera .xer schedule program files:
 - 1. Initial CPM Schedule at the Pre-construction Conference.
 - 2. Original CPM Schedule within thirty (30) days of Notice to Proceed (NTP).
 - 3. Adjustments to the CPM Schedule as required.
 - 4. CPM Schedule updates monthly, five (5) days prior to monthly progress meeting.
- D. Submit three (3) copies and one (1) electronic PDF copy of the reports listed in Section 013200 "Progress Schedules and Reports" with:
 - 1. Initial CPM Schedule
 - 2. Original CPM Schedule
 - 3. Each monthly Schedule update
 - 4. Each weekly three (3) week look ahead Schedule
- E. Progress Schedules and Reports shall be submitted electronically, in addition to hard copies as specified above.

1.8 QUALITY CONTROL SUBMITTALS

- A. Design Data: Not applicable.
- B. Test Reports: Three (3) copies minimum. One (1) copy will be marked with Architect's/Engineer's review comments and returned to Contractor.
 - 1. Indicate that material or product conforms to or exceeds specified requirements.
 - 2. Reports may be from recent or previous tests on material or product, but must be acceptable to Construction Manager. Comply with requirements of each individual specification Section.
- C. Certificates: Three (3) copies minimum. One (1) copy will be marked with Architect's/Engineer's review comments and returned to Contractor.
 - 1. Indicate that material or product conforms to or exceeds specified requirements.
 - 2. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 3. Certificates may be recent or from previous test results on material or product, but must be acceptable to Construction Manager.

- D. Manufacturers' Instructions: Three (3) copies minimum. One (1) copy will be marked with Architect's/Engineer's review comments and returned to Contractor.
1. Include manufacturer's printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing.
 2. Identify conflicts between manufacturer's instructions and Contract Documents.

1.9 COMPUTER PROGRAMS

- A. When any equipment requires operation by computer programs, submit copy of program on CD(s) plus all user manuals and guides for operating the programs and making changes in the programs for upgrading and expanding the databases. Provide required licenses to District at no additional cost.
1. Include at least three (3) years prepaid software license renewals, which includes software upgrades and updates.

1.10 PROJECT RECORD DOCUMENTS

- A. Submit one copy of each of the Project Record Documents listed in Section 017800 - Project Record Documents.

1.11 DELAY OF SUBMITTALS

- A. Delay of submittals by Contractor is considered avoidable delay. Liquidated damages incurred because of late submittals will be assessed to the Contractor.

PART 2 - PRODUCTS

2.1 SUBMITTALS

- A. Within fifteen (15) calendar days after Start Date of the Contract Time submit two (2) copies and one (1) electronic PDF of complete list of substitutions of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. Contractor shall be responsible for and make all submissions.
1. Submit items specified herein to Architect and Construction Manager.
 2. Submit all submittals through the Construction Manager's Electronic Submittal Program.
 3. Identify each transmittal using the 6-digit specification number, i.e., metal handrails might be numbered 05 5000, along with an individual submittal number for each section number. Submittal numbers shall be sequential. If returning submittal "12" for re-submission, second submission would be identified as "12A". Should submittal be rejected multiple times (12b, 12c, etc), the Contractor may be required to reimburse the District/Architect for labor to review subsequent submissions.
 4. Develop, for maintenance by the Construction Manager, a schedule of all submittals and their status. Refer to Paragraph 1.3 below. The schedule will be reviewed each week at the project meeting.
- C. Transmittals, shop drawings, or samples submitted to Architect shall have the Contractor's stamp on it with his signature and be marked "approved." Contractor's stamp on these items indicates that Contractor has performed the following:
1. Verified field dimensions and quantities.
 2. Verified field construction criteria, materials, catalog numbers and similar data.
 3. Reviewed and coordinated submittal data with requirements of the Work and the Contract Documents.
 4. ITEMS NOT STAMPED BY THE CONTRACTOR WILL BE RETURNED UNREVIEWED.

- D. Indicate any item, component, material or portion of Work, which deviates from Contract Documents. Unless such departures are accepted as indicated in paragraph "Review" below, such departures will not be permitted.
- E. Make submittals sufficiently in advance of data required to allow Architect reasonable time for review and additional resubmission and review cycles if necessary.
 - 1. Items submitted without Contractor's review stamp will be returned, without action, for resubmission.
 - 2. Items not submitted in accordance with provisions of this Section will be returned, without action, for resubmission.
 - 3. Submissions on items not approved for use by specifications or addenda will be rejected.
 - 4. Drawings transmitted by other than the Prime Contractor will be returned to the Prime Contractor without action of any kind. Drawings will not be returned to subcontractors.

2.2 SUBMITTALS - PRODUCT DATA

- A. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.
- B. Tabulate products by specification section number.
- C. Supplemental Data:
 - 1. Submit number of copies, which Contractor requires, plus three (3) copies, which will be retained by Construction Manager.
 - 2. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturer's standard data to provide information unique to Project.
 - 3. Manufacturer's standard details and installation instructions.
- D. Provide copies for Project Record Documents described in Section 017000 - Contract Closeout.

2.3 SUBMITTALS - SHOP DRAWINGS

- A. Identify drawings with manufacturer, item, use, type, project designation, specification section or drawing detail reference.
- B. Minimum Sheet Size: 8-1/2 inches by 11 inches. All others: Multiples of 8-1/2 inches by 11 inches, 34 inches by 44 inches maximum.
- C. For 8-1/2 inch by 11 inch and 11 inch by 17-inch sheets, submit number of copies, which contractor requires plus three (3) copies, which will be retained by Construction Manager.
- D. For 17 inch by 22 inch through 34 inch by 44-inch sheets, submit one electronic and a minimum of three prints. After review, reproduce and distribute.
- E. Original sheet or reproducible transparency will be marked with Architect's/Engineer's review comments and returned to Contractor.
- F. Each sheet/copy must include project name and project number and bid number on all sheets.
- G. Mark each copy to identify applicable Products, models, options, and other data; supplement manufacturers' standard data to provide information unique to Work.
- H. Include manufacturers' installation instructions when required by specification section.
- I. Submit a copy of the Shop Drawing Transmittal Form with each submittal and resubmittal.

2.4 SUBMITTALS - SAMPLES

- A. Identify samples with manufacturer's name, item, use, type, project designation, specification section or drawing detail reference, color, range, texture, finish and other pertinent data.
 - 1. Submit samples to illustrate functional and aesthetic characteristics of Product, with integral parts and attachment devices. Coordinate submittal of different categories for interfacing work.
- B. Submit full range of manufacturers' standard colors, textures, and patterns for Construction Manager's selection.
- C. Submit a minimum of three (3) samples unless otherwise specified in the construction documents.
- D. Sizes: Unless otherwise specified, provide the following:
 - 1. Paint Chips: Manufacturers' standard
 - 2. Flat or Sheet Products: Minimum 6 inches square, maximum 12 inches square
 - 3. Linear Products: Minimum 6 inches, maximum 12 inches long
 - 4. Bulk Products: Minimum 1 pint, maximum 1 gallon
- E. Full size samples may be used in Work upon approval.
- F. Mock-ups:
 - 1. Erect field samples and mock-ups at Project site in accordance with requirements of Specification sections.
 - 2. Modify or make additional field samples and mock-ups as required to provide appearance and finishes approved by Construction Manager.
 - 3. Approved field samples and mock-ups may be used in Work upon approval.
- G. Architect may, at his option, retain samples for comparison purposes until completion of Work.
 - 1. Samples will be returned or may be used in the Work unless the technical section specifically indicates otherwise.
 - 2. Remove samples when directed.
 - 3. Pay all costs of furnishing or constructing, and removing samples.
- H. Resubmit samples of rejected items.
- I. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- J. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect and Construction Manager.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT REVIEW

- A. General: Architect and Construction Manager will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect and Construction Manager will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect and Construction Manager will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken.
- C. Reproduce and distribute submittals that the Architect reviews and stamps as follows, to indicate the action taken:
 - 1. Action Codes Permitting Use:
 - a. Code AP - NO EXCEPTIONS TAKEN: Accepted subject to its compatibility with future submittals and additional partial submittals for portions of the work not covered in this submittal. Does not constitute approval or deletion of specified or required items not shown on the submittal. The Work covered by the submittal item may proceed, provided it complies with Contract Document requirements.
 - b. Code AN - MAKE CORRECTIONS NOTED (NO RESUBMISSION REQUIRED): The Work covered by the submittal item may proceed, except minor corrections noted shall be made by Contractor, provided the submittal complies with the Architect's notations and Contract Document requirements.
 - c. Code AN-R - REVISE AND RESUBMIT: Rejected because of major inconsistencies or errors which shall be resolved or corrected by Contractor prior to subsequent review by Architect/Engineer. Do not deliver or install the related work until the resubmittal has received Code AP or AN. However, fabrication and other off-site work covered by the submittal item may proceed, at the Contractor's risk, provided it complies with the Architect's notations and Contract Document requirements.
 - 1) Submit Specified Item: When submittal is marked "Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
 - a) Do not permit submittals marked "Revise and Resubmit" to be used at the Project site, or elsewhere where Work is in progress.
 - 2. Action Code Prohibiting Use:
 - a. Action Code REJ - REJECTED (RESUBMIT): Submitted material does not conform to Plans and Specifications in major respect, i.e.: general non-compliance, wrong size, model, capacity, or material. The Work covered by the submittal item, including purchasing, fabrication, delivery, and other activity, shall not proceed. Revise the submittal item or prepare a new item in accordance with the Architect's notations. Resubmit the corrected or new item without delay; do not permit submittal items marked "Not Approved" to be used. Work incorporating such items will be rejected.

3. Action Code for Items Not Required:
 - a. Action Code X - NO ACTION TAKEN: The submittal item is not called for by the Contract Documents and is being returned unreviewed by the Architect except to the extent necessary to determine its status.
 - D. Informational Submittals: For Architect's information only. Architect and Construction Manager will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect and Construction Manager will forward each submittal to appropriate party.
 1. Action Code for Information Only:
 - a. Action Code INF - INFORMATION ONLY - Received: The submittal item is not called for a return with a reviewed action code by the Contract Documents and is being returned unreviewed by the Architect except to the extent necessary to determine its status.
 - E. Contractor shall retain 1 copy of each "Reviewed," "Reviewed -- Additional Information Required" or "Furnish as Corrected" submittal on file at the job site.
 - F. Architect shall retain 1 copy of each "Reviewed," "Reviewed -- Additional Information Required" or "Furnish as Corrected" submittal in the project file.
 - G. Contractor shall resubmit items stamped "Revise and Resubmit" or "Rejected" by Architect.
 1. Provide a print of previous drawing with resubmission for comparison.
 2. Add letter suffix to previous transmittal number, to indicate resubmission.
 3. It shall be the Contractor's responsibility to assure that previously approved documents are destroyed when they are superseded by a resubmittal.
 - H. When an action code permitting use is assigned to a submittal, it does not authorize work that does not comply with the requirements of the Contract Documents. Acceptance of the Work will depend on compliance.
 1. Architect's review is for general conformance and does not:
 - a. Permit departure from Contract Documents.
 - b. Relieve Contractor from responsibility for errors in detail, in dimensions or related items.
 - c. Approve departure from previous instructions or details.
 - d. Relieve Contractor of the responsibility to provide all components, wiring, etc., required to make item operable or usable.
 - e. Imply acceptance of items for which no data is submitted.
 - f. Imply that Architect has reviewed all dimensions and quantities. Contractor is responsible for determining accuracy of dimensions and quantities.
 - I. Notify Architect of deviations from the Contract Documents.
 - J. Reviewed samples submitted or constructed and approved by Architect constitute criterion for judging completed work. Finish work or items not equal to samples will be rejected.
 - K. Start of work which requires submittals, prior to return of submittals with Architect or District's stamp indicating review and approval is at Contractor's risk.
- 3.3 DISTRIBUTION**
- A. Contractor shall copy and distribute all "Reviewed," "Reviewed -- Additional Information Required" or "Furnish as Corrected" submittals, including one copy to the District.

END OF SECTION

SECTION 013516 - ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes special procedures for alteration work.
- B. Related Requirements:
 - 1. Section 024100 "General Demolition Procedures."
 - a. Coordinate work of this section with demolition Section 024100 as required. If conflicts arise, notify Architect in writing. Do not proceed with work until Architect determines best course of action.

1.2 DEFINITIONS

- A. Alteration Work: This term includes demolition, cutting and patching, remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. Consolidate: To strengthen loose or deteriorated materials in place.
- C. Design Reference Sample: A sample that represents the Architect's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.
- D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Architect.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
- G. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- H. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- I. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- J. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- K. Retain: To keep an element or detail secure and intact.
- L. Strip: To remove existing finish down to base material unless otherwise indicated.

1.3 COORDINATION

- A. Alteration Work Schedule: A construction schedule coordinating the sequencing and scheduling of alteration work for entire Project, including each activity to be performed, and based on Contractor's Demolition and Construction Schedules. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.

1. Schedule demolition and construction operations in sequence required to obtain best Work results.
 2. Coordinate Alteration Work Schedule with Demolition Schedules included in section 024100 "General Demolition Procedures."
 3. Coordinate sequence of alteration work activities to accommodate the following:
 - a. District's continuing occupancy of portions of existing and/or adjacent buildings.
 - b. District's partial occupancy of completed Work.
 - c. Other known work in progress.
 - d. Tests and inspections.
 4. Detail sequence of alteration work, with start and end dates.
 5. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
 6. Use of elevator and stairs.
 7. Equipment Data: List gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- B. Pedestrian and Vehicular Circulation: Coordinate alteration work with circulation patterns within Project building(s) and site. Some work is near circulation patterns . Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of work. Plan and execute the Work accordingly.

1.4 PROJECT MEETINGS FOR ALTERATION WORK

- A. Preliminary Conference for Alteration Work: Before starting alteration work, conduct conference at Project site.
1. Attendees: In addition to representatives of District, Architect, and Contractor, testing service representative, specialists, and chemical-cleaner manufacturer(s) shall be represented at the meeting.
 2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
 - a. Alteration Work Schedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Fire-prevention plan.
 - c. Governing regulations.
 - d. Areas where existing construction is to remain and the required protection.
 - e. Hauling routes.
 - f. Sequence of alteration work operations.
 - g. Storage, protection, and accounting for salvaged and specially fabricated items.
 - h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
 - i. Demolition requirements indicated in other Sections, including Section 024100 "General Demolition Procedures."
 - j. Qualifications of personnel assigned to alteration work and assigned duties.
 - k. Requirements for extent and quality of work, tolerances, and required clearances.
 - l. Embedded work such as flashings and lintels, special details, collection of waste, protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.
 3. Reporting: Record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.
- B. Coordination Meetings: Conduct coordination meetings specifically for alteration work at weekly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: In addition to representatives of District, Architect, and Contractor, each specialist, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of alteration work activities shall be represented at these meetings. All participants at conference shall be familiar with Project and authorized to conclude matters relating to alteration work.
2. Agenda: Review and correct or approve minutes of previous coordination meeting. Review other items of significance that could affect progress of alteration work. Include topics for discussion as appropriate to status of Project.
 - a. Alteration Work Subschedule: Review progress since last coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited with retention of quality; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities are completed within the Contract Time.
 - b. Schedule Updating: Revise Contractor's Alteration Work Subschedule after each coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each entity present, including review items listed in the "Preliminary Conference for Alteration Work" Paragraph in this article and the following:
 - 1) Interface requirements of alteration work with other Project Work.
 - 2) Status of submittals for alteration work.
 - 3) Access to alteration work locations.
 - 4) Effectiveness of fire-prevention plan.
 - 5) Quality and work standards of alteration work.
 - 6) Change Orders for alteration work.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.5 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, alterations waste becomes property of Contractor.
- B. Historic items, relics, and similar objects as occurs, including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to District that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain District's property.
 1. Carefully dismantle and salvage each item or object in a manner to prevent damage and protect it from damage, then promptly deliver it to District where directed at Project site.

1.6 INFORMATIONAL SUBMITTALS

- A. Alteration Work Schedule:
 1. Submit alteration work subschedule within 30 days of date established for Notice to Proceed. In addition to alteration work, include the following:
 - a. Implementation and Termination Schedule: Include information indicating implementation and termination dates of each temporary utility.
 - b. Demolition Subschedule: Include high-level general dates and durations for site, selective, and building demolition required by Section 024100 "General Demolition Procedures."
- B. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- C. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements that are to remain, including finish surfaces, that might be misconstrued as damage caused by Contractor's alteration work operations.

- D. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- E. Alteration Work Program: Prepare a written plan for alteration work for entire Project, including each phase or process and protection of surrounding materials during demolition, site alterations and development, and construction operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections. Include the following information:
1. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control during demolition and throughout the remainder of the alteration Work. Indicate proposed locations and construction of barriers.
 - a. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain including means of egress from those buildings.
 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
 3. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold during demolition and alteration activities. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
 - a. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
 - b. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
 - c. Indicate methods to be used to avoid trapping water in finished work.
 4. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation during demolition and alteration activities. Include the following:
 - a. Locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
 - b. HVAC system isolation schematic drawing.
 - c. Location of proposed air-filtration system discharge.
 - d. Waste-handling procedures.
 - e. Other dust-control measures.
 5. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the District during demolition and alteration activities. Include the following:
 - a. Methods used to meet the goals and requirements of the District.
 - b. Concrete cutting method(s) to be used.
 - c. Location of construction devices on the site.
 - d. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
 - e. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the District.
 - f. Indicate locations of sensitive equipment areas or other areas requiring special attention as identified by Owner. Indicate means for complying with District's requirements.

6. Fire-Prevention Plan: Within 30 days of date established for Notice to Proceed, unless more stringent is required by AHJ or District, prepare and submit a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Coordinate plan with District's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.
 - a. Indicate Contractor personnel responsible for management of fire-prevention program during demolition and alteration activities.
7. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent, for work during demolition and subsequent construction activities.

1.7 CLOSEOUT SUBMITTALS

- A. General: Refer to Section 017000 "Contract Closeout."

1.8 QUALITY ASSURANCE

- A. Specialist Qualifications: An experienced firm regularly engaged in specialty work similar in nature, materials, design, and extent to alteration work as specified in each Section and that has completed a minimum of five recent projects with a record of successful in-service performance that demonstrates the firm's qualifications to perform this work.
 1. Field Supervisor Qualifications: Full-time supervisors experienced in specialty work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on-site when specialty work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.
 - a. Construct new mockups of required work whenever a supervisor is replaced.
- B. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a "Lead-Safe Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.
- C. Safety and Health Standard: Comply with ANSI/ASSP A10.6.
- D. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- E. Accessible Temporary Egress: Comply with applicable provisions in the CBC Title 24 Chapter 11B during demolition and alterations work.

1.9 FIELD CONDITIONS

- A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of preconstruction photographs.
 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
- B. Buildings immediately adjacent to demolition and alteration areas may be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
 1. Provide not less than 72 hours notice of activities that will affect operations of adjacent occupied buildings.
 2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
 - a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.

- C. Discrepancies: Notify Architect of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.
- D. Size Limitations in Existing Spaces: Materials, products, and equipment used for performing the Work and for transporting debris, materials, and products shall be of sizes that clear surfaces within existing spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Refer to individual Specification Sections and Drawings for products, materials, and equipment.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.
 - 1. Use only proven protection methods, appropriate to each area and surface being protected.
 - 2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
 - 3. Erect temporary barriers to form and maintain fire-egress routes.
 - 4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
 - 5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces.
 - 6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
 - 7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
 - 8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.
- B. Temporary Protection of Materials to Remain:
 - 1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
 - 2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
 - 1. Notify District, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
 - 2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
 - 3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.

1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from alteration work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

F. Existing Roofing: Prior to the start of work in an area, install roofing protection as indicated on Drawings.

3.2 PROTECTION FROM FIRE

A. General: Follow fire-prevention plan and the following:

1. Comply with NFPA 241 requirements unless otherwise indicated. Perform duties titled "District's Responsibility for Fire Protection."
2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
 - a. If combustible material cannot be removed, provide fire blankets to cover such materials.

B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:

1. Obtain District's approval for operations involving use of welding or other high-heat equipment. Use of open-flame equipment is not permitted. Notify District at least 72 hours before each occurrence, indicating location of such work.
2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
 - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
 - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
 - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
 - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
 - e. Maintain fire-watch personnel at Project site until two hours after conclusion of daily work.

C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.

D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.

1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is complete.

3.3 PROTECTION DURING APPLICATION OF CHEMICALS

- A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.
- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off District's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

3.4 GENERAL ALTERATION WORK

- A. Have specialty work performed only by qualified specialists.
- B. Ensure that supervisory personnel are present when work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs. Comply with requirements in Section 013233 "Photographic Documentation."
- D. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.
- E. Notify Architect of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
 - 1. Do not proceed with the work in question until directed by Architect.
- F. Refer to Section 024100 "General Demolition Procedures" for requirements specific to demolition work that may also apply to alterations work of this Section.

END OF SECTION 013516

SECTION 013573 - DELEGATED DESIGN REQUIREMENTS AND PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes procedures for portions of Work under this Contract that include delegated design requirements and procedures.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for quality control of submittal procedure and coordination with delegated design requirements.

1.2 DEFINITIONS

- A. Delegated Design: A portion or component of the Work identified by the Contract Documents to be designed by the Contractor, or an entity assigned by the Contractor, to satisfy performance and design criteria specified in the Contract Documents for that portion or component.
- B. Registered Design Professional: Design professional, assigned by the Contractor, who is responsible for providing the delegated design work, and for certifying that the work is in compliance with the specified performance requirements and design criteria. Design professional shall be legally qualified to practice in jurisdiction where Project is located and shall be experienced in providing delegated design services of the kind indicated. Delegated design services are defined as those performed for installation of the system, assembly or product that are similar in material, design, and extent to those indicated for this Project.
- C. AHJ: Authority having jurisdiction.
- D. Technical Sections: Specification sections included in Divisions 02 through 33 of the Project Manual.

1.3 SUBMITTAL PROCEDURES

- A. Performance and Design Criteria: Where delegated design services are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If specific performance and design criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
 - 2. Architect's and Engineer's review of delegated design submittal shall be for conformance with performance and design criteria only.
- B. Delegated-Design Services Submittal: Include Shop Drawings, Product Data, and other required submittals indicated in individual technical sections. Submit digitally signed PDF electronic file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. In addition to other submittal requirements specified in other technical sections, at minimum, include the following in delegated design submittal:
 - a. Statement of design and performance criteria identified by the Contract Documents.
 - b. Assumptions.
 - c. Details, calculations, etc. related to the performance criteria.
 - d. Reactions to structure (where applicable).
 - e. Instructions for fabrication, assembly, installation, and interface with other trades.
 - 2. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

- C. BIM File Incorporation: Incorporate delegated-design drawing and data files into Building Information Model established for Project.
1. Prepare delegated-design drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.
- D. Submittal Procedures for Delegated Design Components:
1. Comply with requirements specified for other types of submittals included in this Section, including, but not limited to, form and procedures for delivering submittals.
 - a. Submit delegated design documents for approval prior to fabrication of components included in delegated design work.
 - b. Architect's review of delegated design submittals is for the limited purpose of checking for general conformance with information given and the design intent expressed in the Contract Documents. Architect will review submittals consistent with this limited purpose.
 - 1) Architect's review does not lessen nor shift burden or responsibility from Contractor to Architect or Owner.
 - 2) If during submittal review, Architect notes any deficiencies or errors, submittal will be returned with comments. Otherwise, there will be no responsive action by Architect.
 2. Delegated Design Submittal Schedule: Submit list of items identified in the Contract Documents that require delegated design. For each item, include the delegated design entity and the registered design professional.
 - a. If required, submit schedule to the authority having jurisdiction.
 3. Preliminary Submission: In order to avoid engineering and detailing of an unacceptable design, and if required by individual technical section, submit to Architect, preliminary documentation describing registered design professional's design prior to preparing engineering calculations and shop drawings.
 4. Delegated Design Submission: Submit final delegated design documents to Architect and AHJ if required for review, allowing not less than 10 days for review by Architect, and Architect's consultants and AHJ.
 - a. Comply with AHJ requirements.
 - b. Ensure registered design professional's signed seal is affixed to documents in accordance with jurisdictional requirements.
 - c. Make corrections noted by Architect and comply with AHJ requirements.

1.4 RESPONSIBILITIES

- A. General Contractor's Responsibilities:
1. Ensure drawings, calculations, specifications, and other documentation provided by registered design professional are complete and are sealed and signed by the registered design professional in accordance with requirements of AHJ. Architect and Owner shall be entitled to rely on the completeness and accuracy of the documentation provided by the registered design professional.
 2. Coordinate and assign complete responsibility for design, documentation, calculations, and submittal of delegated design components.
 3. Coordinate components requiring delegated design with adjacent or related systems whether designed by Architect or another entity. Ensure complete, operational systems that perform their intended are provided.
 4. When required to be reviewed by AHJ, submit delegated design documentation for in a timely manner that will not negatively impact Project's construction schedule.
 5. Performance requirements and design criteria are described in each technical section requiring delegated design. Conduct thorough review of other related portions of the Contract Documents to ensure inclusion of full scope of work in delegated design preparation and submittals.
 - a. Provide products and systems complying with specific performance and design criteria indicated.

6. Comply with quality assurance requirements specified in individual technical sections containing delegated design requirements.
 7. Comply with accessibility guidelines, codes, policies, and standards required by the AHJ, applicable to the project, and as indicated.
- B. Registered Design Professional: Responsibilities include, but are not limited to, the following:
1. Sole responsibility to ensure delegated design accommodates all building movements, including, but not limited to deflection, rotation, creep, shrinkage, live loads, wind loads, and loads, interim and otherwise, resulting from means and methods.
 2. If applicable, prepare documentation required by AHJ.
 3. Prepare delegated design submittals that are sealed and signed by registered design professional.
- C. Architect's Responsibilities: Architect will review and mark submittals in accordance with procedures defined in Section 013300 "Submittal Procedures", using the action codes defined in that section.

1.5 SCHEDULING

- A. Schedule delegated design activities and submittals to occur in a timely manner that will not negatively impact Project's construction schedule.
1. Allow sufficient time for Architect's review of delegated design submittals.
 2. If Architect's approval of shop drawings relating to delegated design components is required prior to application for permit, schedule and sequence delegated design shop drawing review prior to permit submittal. Comply with requirements of Section 013300 "Submittal Procedures."
- B. Owner will not be responsible to pay for delays, additional products, additional hours of work, including overtime, restocking or rework required due to failure by Contractor to coordinate delegated design work with work of other trades.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013573

SECTION 014100 - REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes regulatory requirements applicable to Contract.

1.2 REFERENCES TO REGULATORY REQUIREMENTS

- A. Codes, laws, ordinances, rules and regulations referred to shall have full force and effect as though printed in full in these specifications.
- B. Conform to referenced codes, laws, ordinances, rules and regulations, which are in effect on date of receipt of bids.

1.3 CODES

- A. Codes, which apply to Contract, include, but are not limited to, the following:
 - 1. Current California Building Code (Part 2, Title 24, C.C.R.)
 - 2. Current California Electrical Code (Part 3, Title 24, C.C.R.)
 - 3. Current California Mechanical Code (Part 4, Title 24, C.C.R.)
 - 4. Current California Plumbing Code (Part 5, Title 24, C.C.R.)
 - 5. Current State Elevator Safety Regulations (Part 7, Title 24, C.C.R.)
 - 6. Current California Fire Code (Part 9, Title 24, C.C.R.)
 - 7. Current California Energy Code (Part 6, Title 24, C.C.R.)

1.4 LAWS, ORDINANCES, RULES AND REGULATIONS

- A. During prosecution of Work to be done under Contract, comply with applicable laws, ordinances, rules and regulations, including, but not limited to, the following:
- B. Federal
 - 1. Americans With Disabilities Act
 - 2. 29 CFR, Section 1910.1001, Asbestos
 - 3. 40 CFR, Subpart M, National Emission Standards for Asbestos
 - 4. Executive Order 11246
- C. State of California
 - 1. California Code of Regulations, Titles 5, 8, 19, 21, 24
 - 2. California Education Code
 - 3. California Public Contract Code
 - 4. California Health and Safety Code
 - 5. California Government Code
 - 6. California Labor Code
 - 7. California Civil Code
 - 8. California Code of Civil Procedure
 - 9. CPUC General Order 95, Rules for Overhead Electric Line Construction
 - 10. CPUC General Order 128, Rules for Construction of Underground Electric Supply and Communications Systems
- D. State of California Agencies
 - 1. Bay Area Air Quality Management District (BAAQMD / www.baaqmd.gov)
 - 2. State and Consumer Services Agency
 - 3. Department of General Services

4. Division of the State Architect

E. Local Agencies:

1. City of Hayward, California (www.ci.hayward.ca.us)
2. City of Livermore, California [Livermore, CA | Home \(livermoreca.gov\)](http://livermore.ca.gov)

1.5 COMPLIANCE WITH AMERICANS WITH DISABILITIES ACT

- A. Contractor acknowledges that, pursuant to the Americans with Disabilities Act (ADA), programs, services and other activities provided by a public entity to the public, whether directly or through a contractor, must be accessible to the disabled public. Contractor shall provide the services specified in this Agreement in a manner that complies with the ADA and any and all other applicable federal, state and local disability rights legislation. Contractor agrees not to discriminate against disabled persons in the provision of services, benefits or activities provided under this Agreement and further agrees that any violation of this prohibition on the part of Contractor, its employees, agents or assigns shall constitute a material breach of this Agreement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 014110 - REGULATORY REQUIREMENTS - HAZARDOUS WASTE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes regulatory requirements applicable to Contract work in connection with hazardous waste abatement and disposal, when encountered during demolition or construction, including, but not limited to, asbestos and asbestos containing materials, lead based paint, polychlorinated biphenyls, petroleum contaminated soils and materials, construction and demolition debris and any other hazardous substance or hazardous waste.
- B. This section supplements Section 014100 and the work specific listings of applicable regulatory requirements elsewhere in the specifications.
- C. Related Sections.
 - 1. Section 014100: Regulatory Requirements.

1.2 REFERENCES TO REGULATORY REQUIREMENTS

- A. Codes, laws, ordinances, rules and regulations applicable to the Work shall have full force and effect as though printed in full in these specifications. Codes, laws, ordinances, rules and regulations are not furnished to Contractor, since Contractor is assumed to be familiar with their requirements. The listing herein of applicable codes, laws and regulations for hazardous waste abatement work is supplied to Contractor as a courtesy and shall not limit Contractor's responsibility for complying with all applicable laws, regulations or ordinances having application to the Work. Where conflict among the requirements or with these specifications exists, the most stringent requirements shall be used.
- B. Contractor's work shall conform to all applicable codes, laws, ordinances, rules and regulations that are in effect on date of receipt of bids.

1.3 LAWS, ORDINANCES, RULES AND REGULATIONS

- A. During prosecution of Work under Contract, Contractor shall comply with applicable laws, ordinances, rules and regulations, including, but not limited to, those listed below.
- B. Federal:
 - 1. Statutory Requirements:
 - a. Resource Conservation and Recovery Act, 42 U.S.C.. 6901 et seq.
 - b. Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986,42 U.S. C" 9601 et seq.
 - c. Toxic Substances Control Act of 1976,15 U.S.C.. 2601 et seq.
 - d. Hazardous Materials Transportation Act of 1975, 49 U.S. C" 1801 et seq.
 - e. Clean Water Act, 33 U.S.C.. 1251 et seq.
 - f. Safe Drinking Water Act, 42 U.S. C.. 3001 et seq.
 - g. Clean Air Act, section 112, 42 U.S. C.. 7412
 - h. Occupational Safety and Health Act of 1970, 29 U.S.C.. 651 et seq.
 - i. Underground Storage Tank Law, 42 U.S. C.. 6991 et seq.
 - j. The Emergency Planning and Community Right to Know Act of 1986,42 U.S.C.. 11001 et seq.
 - 2. Environmental Protection Agency (EPA):
 - a. 40 C.F.R. Parts. 260, 264, 265, 268, 270
 - b. 40 C.F.R. Parts 258 et seq.

- c. 40 C.F.R. Part 761
 - d. 40 C.F.R. Parts 122-124
 - 3. Occupational Safety and Health Administration (OSHA):
 - a. OSHA Worker Protection Standards, Title 29 CFR Part 1926.58, Construction Standards and 29 CFR 1910.1001 General Industry Standard
 - b. OSHA, 29 C. F. R. Part 1926.1101, Construction Standards for Asbestos
 - c. OSHA, Lead Exposure in Construction: Interim Final Rule, 29 C.F.R. 1926.62
 - d. National Emission Standard for Hazardous Air Pollutants, Title 40 CFR Part 61
 - e. Asbestos Hazardous Emergency Response Act, Title 40 C.F.R. 763
 - 4. Department of Transportation:
 - a. Title 49 C.F.R. 173.1090
 - b. Title 49 C.F.R.172
 - c. Title 49 C.F.R. 173
 - d. DOT, HM 181 and MH126f
- C. State of California Requirements:
- 1. Statutory Law:
 - a. The Carpenter-Presley-Tanner Hazardous Substance Account Act, Cal. Health & Saf. Cod~ 25300 et seq.
 - b. Health and Safety Cod~ 25359.4
 - c. Hazardous Waste Control Law, Health & Safety Code. 25100 § seq.
 - d. Porter Cologne Water Quality Control Act, Cal. Water Cod~ 13000 et seq.
 - e. Health and Safety Cod~ 25915-25924
 - f. Cal. Labor Code Chapter 6, including, without limitation,, 6382, 6501.5-6501.9,6503.5, 9021.5, 9080
 - g. Cal. Bus. and Prof. Code, including without limitation,, 7058.5, 7065.01, 7118.5. Underground Storage of Hazardous Substance Act,
 - h. Cal. Health & Saf. Cod~ 25280 § seq.
 - i. Petroleum Underground Storage Tank Cleanup, Health and Safety Cod~ 25299.10 et seq.
 - j. Safe Drinking Water and Toxic Enforcement Act of 1986, Health & Saf. Cod~ 25249.5 et seq. (Proposition 65)
 - k. Above Ground Petroleum Storage Act, Health and Safety Code. 25270 et seq.
 - 2. Hazardous Materials Release Response Plans and Inventory, California Health and Safety Code Chapter 6.95.
 - 3. Administrative Code and Regulations:
 - a. 22 C.C.R.. 6600 et seq.
 - b. Title 22 C.C.R.. Standards for Management of Hazardous and Extremely Hazardous Waste
 - c. DTSC Treatment Standard for PCB Wastes, Title 22 C.C.R.,. 66268.110
 - d. Cal OSHA Worker Protection Standards, Title 8 C.C.R.. 1529, 5208
 - e. Title 8 C. C. R.. 1532.1, Lead in Construction
 - f. 22 C.C.R.. 66999(b)
 - g. Title 23 C.C.R.. 2610 et seq.
 - 4. Local Agency Requirements:
 - a. Bay Area Air Quality Management District, Fugitive Dust Rules
 - b. Bay Area Air Quality Management District Regulation 11-2-303
 - c. State Water Resource Control Board, General Construction Activity Stormwater Permit Requirements (Order 92-0S DWQ)
 - 5. City Requirements:
 - a. Hayward Fire Department (www.haywardcal.us/fire_dept/fd.htm)
 - b. Livermore-Pleasanton Fire Department Livermore Fire Department | Home Fire (lfire.org)
 - c. Livermore Municipal Water Department Recycled Water | Livermore, CA (livermoreca.gov)
 - d. Ordinances

1.4 PERMITS

- A. Contractor shall comply with, implement or acknowledge effectiveness of all CLPCCD held permits, and initiate and cooperate in securing all required notifications or approvals therefore, including but not limited to permits affecting environmental work and the following:
1. BAAQMD, Permit to Excavate or Treat Contaminated Soil;
 2. State Water Resources Control Board, General Construction Activity Stormwater Permit

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 014113 - ADDITIONAL REQUIREMENTS FOR DSA REVIEWED PROJECTS

PART 1 - GENERAL

1.1 DSA DEFERRED APPROVALS

- A. Refer to Contract Drawings.

1.2 INSPECTION AND SUPERVISION

- A. Supervision by DSA shall be in accordance with Section 4-334 of Part 1, Title 24, CCR.
- B. District shall employ a full-time Project Inspector approved by DSA. The Project Inspector shall observe construction in accordance with Section 4-333(b) and 4-342 of Part 1, Title 24, CCR.
- C. Reports: Project Inspector shall submit the following in accordance with DSA IR A-7.
 - 1. Start of Project Report: Notify DSA of start of construction in accordance with Section 4-331 of Part 1, Title 24, CCR.
 - 2. Semi-Monthly Reports: Comply with Section 4-337 of Part 1, Title 24, CCR.
 - 3. Verified Reports: Comply with Section 4-336 of Part 1, Title 24, CCR.
- D. Special Inspection Requirements:
 - 1. Comply with Section 4-333(c) of Part 1, Title 24, CCR.
 - 2. Special inspection costs are to be paid by the Owner.
 - 3. Conduct special inspection as per DSA Structural Tests and Inspections Sheet (SSS 103-1).

1.3 TESTING LABORATORY REQUIREMENTS

- A. Comply with Section 4-335 of Part 1, Title 24, CCR.
- B. The Owner shall select the testing Laboratory approved by DSA, Architect, and Structural Engineer.
- C. Sampling and testing shall be performed by properly qualified persons in accordance with American Society for Testing and Materials (ASTM) standards.
- D. Conduct tests as per DSA Structural Tests and Inspections Sheet (SSS 103-1).
- E. Submit one copy of test reports to DSA.

1.4 ADDENDA AND CHANGE ORDERS

- A. Comply with Section 4-338 of Part 1, Title 24, CCR.
- B. Comply with DSA IR A-6.
- C. Obtain DSA approval for changes to code-regulated construction and inspection/testing functions prior to start of that work. Code-regulated construction refers to work that is regulated by code provisions applicable to public school construction, including those adopted by DSA Structural Safety (DSA/SS), DSA Access Compliance (DSA/AC) and State Fire Marshal (SFM).
- D. Changes can be approved through either the change order (CO) process or preliminary change order (PCO) process. Comply with DSA IR A-6, Sub-paragraph 2.2 - Change Order Process and DSA IR A-6, Sub-paragraph 2.1 - Preliminary Change Order Process.
- E. Do not begin any work under addendum or change order until required DSA written approval is obtained.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 014200 - REFERENCES AND DEFINITIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes reference standards, abbreviations, symbols and definitions used in Contract Documents.
- B. Full titles and edition dates are given in this section for standards cited in other sections of Specifications.
- C. Material and workmanship specified by reference to number, symbol, or title of specific standard such as state standard, commercial standard, federal specifications, technical society, or trade association standard, or other similar standard shall comply with requirements of standards except when more rigid requirements are specified or required by applicable codes.
- D. Standards referred to, except as modified herein, shall have full force and effect as though printed in the Contract Documents. Standards are not furnished to Contractor, since manufacturers and trades involved are assumed to be familiar with their requirements.

1.2 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES; REPORTING AND RESOLVING DISCREPANCIES:

- A. Reference to standards, specifications, manuals or codes of any technical society, organization or association, or to the laws or regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard, specification, manual, code or laws or regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated in the Contract Documents.
- B. If during the performance of the Work, Contractor discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any such law or regulation applicable to the performance of the Work or of any such standard, specification, manual or code or of any instruction of any supplier, Contractor shall report it in writing at once to Inspector, with copies to Construction Manager and Architect, and Contractor shall not proceed with the Work affected thereby until consent to do so is given by the Construction Manager.
- C. Except as otherwise specifically stated in the Contract Documents or as may be provided by Change Order, or supplemental instruction, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the Contract Documents and:
 - 1. The provisions of any such standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or
 - 2. The provisions of any such laws or regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such law or regulation).
- D. No provision of any such standard, specification, manual, code or instruction shall be effective to change the duties and responsibilities of CLPCCD, Contractor, Construction Manager, or Architect/Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the Contract Documents, nor shall it be effective to assign to CLPCCD, Architect/Engineer, Construction Manager, or any of their consultants, agents or employees any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

1.3 STANDARDS

- A. ACI (American Concrete Institute)

1. Standard 318, Building Code Requirements for Reinforced Concrete
- B. AISC (American Institute of Steel Construction)
 1. Specifications and Code of Standard Practice for Steel Buildings and Bridges
- C. ANSI (American National Standards Institute, formerly American Standards Association)
 1. Standard C2, NESC (National Electrical Safety Code)
- D. ASTM (American Society for Testing and Materials)
 1. C31, Making and Curing Concrete Test Specimens in the Field
 2. C42, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 3. C143, Test Method for Slump of Portland Cement Concrete
- E. IAPMO (International Association of Plumbing and Mechanical Officials)
- F. ICC (International Code Council)
 1. Refer to Section 014100 – Regulatory Requirements
- G. NEMA (National Electric Manufacturer's Association)
- H. NFPA (National Fire Protection Association)
 1. Pamphlet 1, Fire Prevention Code
 2. Pamphlet 13, Sprinkler Systems, Installation
 3. Pamphlet 24, Private Fire Service Mains
 4. Pamphlet 70, NEC (National Electric Code)
 5. Pamphlet 71, Signaling Systems, Central Station
 6. Pamphlet 80, Fire Doors and Windows
 7. Pamphlet 101, Life Safety Code
- I. UL (Underwriters' Laboratories, Inc.)

1.4 ABBREVIATIONS

- A. Following abbreviations may be used in Contract Documents:
 1. AAP Affirmative Action Program
 2. ACI American Concrete Institute
 3. ADA American Disabled Act
 4. AISC American Institute of Steel Construction
 5. ANSI American National Standards Institute (formerly American Standards Association)
 6. ASI Architect's Supplemental Instructions
 7. ASTM American Society for Testing and Materials
 8. BIL Basic Insulation Level
 9. Cal/OSHA California Occupational Safety and Health Administration
 10. CCD Construction Change Directive
 11. CCR California Code of Regulations
 12. CFR Code of Federal Regulations
 13. CO Change Order
 14. CPUC California Public Utilities Commission
 15. CPM Critical Path Method
 16. DSA Division of State Architect
 17. HVAC Heating, Ventilating and Air Conditioning
 18. IAPMO International Association of Plumbing and Mechanical Officials
 19. ICBO International Conference of Building Officials
 20. I.D. Identification

- 21. JATC Joint Apprenticeship Training Committee
- 22. JV Joint Venture
- 23. Kw Kilowatt
- 24. LBE Local Business Enterprise
- 25. MBE Minority Business Enterprise
- 26. M/WBE Minority and Woman-Owned Business Enterprise
- 27. ml milliliter
- 28. mm millimeter
- 29. NEC National Electric Code
- 30. NEMA National Electric Manufacturer's Association National Electrical Safety Code
- 31. NFPA National Fire Protection Association
- 32. PM Preventive Maintenance
- 33. PR Proposal Request
- 34. RFI Request for Information
- 35. RFS Request for Substitution
- 36. SFM State of California, Office of State Fire Marshal
- 37. CBC California Building Code
- 38. CFC California Fire Code
- 39. UL Underwriters' Laboratories, Inc.
- 40. CMC California Mechanical Code
- 41. CPC California Plumbing Code
- 42. WOBE Woman-Owned Business Enterprise
- 43. WMBE Woman/Minority Business Enterprise
- 44. Additional abbreviations, used only on drawings or specifications, are listed thereon.

1.5 SYMBOLS

- A. Symbols, used only on Drawings, are shown thereon.

1.6 DEFINITIONS

- A. Wherever any of the words or phrases defined below, or a pronoun used in place thereof, is used in any part of the Contract Documents, it shall have the meaning here set forth:
 - 1. **ADDENDA:** Written or graphic instruments issued prior to the opening of Bids, which clarify, correct or change the bidding requirements or the Contract Documents. Addenda shall not include the minutes of the Pre-bid Conference and Site Visit.
 - 2. **ADDITIVE BID:** The sum to be added to the Base Bid if the change in scope of work as described in Additive Bid is accepted by CLPCCD.
 - 3. **AGREEMENT:** Agreement is the basic contract document that binds the parties to construction Work. Agreement defines relationships and obligations between CLPCCD and Contractor and by reference incorporates Conditions of Contract, Drawings, and Specifications and contains Addenda and all Modifications subsequent to execution of Contract.
 - 4. **ALTERNATE:** Work added to or deducted from the Base Bid, if accepted by CLPCCD.
 - 5. **APPROVED EQUAL:** Approved in writing by CLPCCD as being of equivalent quality, utility and appearance.
 - 6. **ARCHITECT or ARCHITECT/ENGINEER:** The person holding a valid California State Architect's license, whose firm has been designated within the Contract Documents as the Architect to provide architectural services on the project. Refer to Section 341, Part 1, Title 24, C. C. R.
 - 7. When the Architect is referred to within the Contract Documents and no Architect has in fact been designated, then the matter shall be referred to CLPCCD. The term Architect shall be construed to include all its consultants retained for the project, as well as employees of the Architect. When the designated Architect is an employee of CLPCCD, his authorized representations on the project within the district will be included under the term Architect.
 - 8. **BID:** The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 - 9. **BIDDER:** One who submits a Bid.
 - 10. **CLPCCD:** Chabot-Las Positas Community College District. Unless otherwise expressly indicated or required by the context of usage, the terms "District" and "Owner" as used in the Contract Documents shall be deemed references to CLPCCD.

11. **CLPCCD-FURNISHED, CONTRACTOR-INSTALLED:** Items furnished by CLPCCD at its cost for installation by Contractor at its cost under this Contract.
12. **CLPCCD REPRESENTATIVE(S):** The person or persons assigned by CLPCCD to be CLPCCD's representatives or, if so designated, agent(s) at the site.
13. **BY CLPCCD:** Work that will be performed by CLPCCD or its agents at the CLPCCD's expense.
14. **BY OTHERS:** Work that is outside scope of Work to be performed by Contractor under this Contract, which will be performed by CLPCCD, other contractors, or other means.
15. **CHANGE ORDER:** A written instrument prepared by CLPCCD and signed by CLPCCD and Contractor, stating their agreement upon all of the following:
 16. a change in the Work,
 17. the amount of the adjustment in the Contract Sum, if any, and
 18. the amount of the adjustment in the Contract Time, if any.
19. As appropriate, change orders are subject to approval by the Division of the State Architect. Refer to section 4-338, Part 1, Title 24, California Code of Regulations.
20. **CONCEALED:** Work not exposed to view in the finished Work, including within or behind various construction elements.
21. **CONTRACT CONDITIONS:** Conditions of Contract define basic rights, responsibilities and relationships of Contractor and CLPCCD and consists of two parts: General Conditions and Supplementary Conditions.
 - a. General Conditions are general clauses, which are common to the CLPCCD Contracts.
 - b. Supplementary conditions modify or supplement General Conditions to meet specific requirements for this Contract.
22. **CONSTRUCTION MANAGER:** CLPCCD's authorized representative, who shall represent CLPCCD in all matters relative to this Contract. Construction Manager may authorize agents and representatives to act in carrying out Construction Manager's duties, including a "Project Manager", to act under the authority of the Construction Manager. As CLPCCD's agent, the Construction Manager is the beneficiary of all contract obligations of Contractor to CLPCCD, including without limitation, all releases and indemnities. Construction Manager shall not have any personal liability arising from this Contract or any activity there under and Contractor releases Construction Manager fully from all loss, cost, damage, expense or liability arising out of or connected with this Project, whether arising from contract, negligence or tort claims of all kinds.
23. **CONTRACT DOCUMENTS:** Contract Documents shall consist of the documents identified as the Contract Documents in Contract Agreement, plus all changes, addenda and modifications thereto.
24. **CONTRACT MODIFICATION:** Either:
 - a. a written amendment to Contract signed by Contractor and CLPCCD; or
 - b. a Change Order; or
 - c. a written directive for a minor change in the Work issued by CLPCCD.
25. **CONTRACT SUM:** The sum stated in the Agreement and, including authorized adjustments, the total amount payable by CLPCCD to Contractor for performance of the Work and the Contract Documents. (Also referred to as the CONTRACT PRICE.)
26. **CONTRACT TIMES:** The number or numbers of days or the dates stated in the Agreement (i) to achieve substantial completion of the Work or designated milestones and/or (ii) to complete the Work so that it is ready for final payment and is accepted.
27. **CONTRACTOR:** The person or entity identified as such in the Agreement and referred to throughout the Contract Documents as if singular in number and neuter in gender. The term "Contractor" means the Contractor or its authorized representative.
28. **CONTRACTOR'S EMPLOYEES:** Persons engaged in execution of Work under Contract as direct employees of Contractor, as subcontractors, or as employees of subcontractors.
29. **DATE OF SUBSTANTIAL COMPLETION:** Date of Substantial Completion of Work or designated portion thereof is date certified by Construction Manager when construction is sufficiently complete in accordance with Contract Documents for CLPCCD to occupy Work or designated portion thereof for its use for which it is intended.
30. **DAY:** One calendar day, unless the word "day" is specifically modified to the contrary.
31. **DEDUCTIVE BID:** The sum to be subtracting to the Base Bid if the change in scope of work as described in Deductive Bid is accepted by CLPCCD.

32. **DEFECTIVE:** An adjective which, when modifying the word "Work", refers to Work that is unsatisfactory or unsuited for the use intended, faulty, or deficient, that it does not conform to the Contract Documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents (including but not limited to approval of samples and "or equal" items), or has been damaged prior to final payment (unless responsibility for the protection thereof has been assumed by CLPCCD). Construction Manager is the judge of whether Work is defective.
33. **DRAWINGS:** The graphic and pictorial portions of Contract Documents, wherever located and whenever issued, showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules and diagrams.
34. **ENGINEER:** Where referenced in the Contract Documents, the person holding a valid California State Engineer's license, whose firm has been designated (if any designated) within the Contract Documents as the Engineer to provide engineering services on the project. Refer to section 4-341, Part 1, Title 24, C.C.R.
35. **EQUAL:** Equal in opinion of Architect. Burden of proof of equality is responsibility of Contractor.
36. **EXPOSED:** Work exposed to view in the finished Work, including behind louvers, grilles, registers and various other construction elements.
37. **FINAL ACCEPTANCE or FINAL COMPLETION:** All Work satisfactorily completed in accordance with Contract Documents. It includes, but is not limited to:
 - a. All Systems having been tested and accepted as having met requirements of Contract Documents.
 - b. All required instructions and training sessions having been given by Contractor.
 - c. All as-built drawings and operations and maintenance manuals and Machine Inventory Sheets having been submitted by Contractor, reviewed by Architect/Engineer and accepted by CLPCCD.
 - d. All punch list work, as directed by CLPCCD, having been completed by Contractor.
 - e. Generally all work, except Contractor maintenance after Final Acceptance, having been completed to satisfaction of CLPCCD.
38. **FORCE-ACCOUNT:** Work directed to be performed without prior agreement as to lump sum or unit price cost thereof, and which is to be billed at cost for labor, materials, equipment, taxes, and other costs, plus a specified percentage for overhead and profit.
39. **FURNISH:** Supply only, do not install.
40. **INDICATED:** Shown or noted on the Drawings.
41. **INSPECTOR:** The person engaged by CLPCCD to inspect the workmanship, materials, or manner of construction of buildings or portions of buildings, to determine if such construction complies with the Contract Documents and applicable codes. The inspector is subject to approval by the Architect, CLPCCD and, as appropriate, Division of the State Architect, and he will report to CLPCCD. Refer to section 4-333 and section 4-342, Part 1, Title 24, California Code of Regulations. The terms "Inspector" and "Project Inspector" are used interchangeably in the Contract Documents.
42. **INSTALL:** Install or apply only, do not furnish.
43. **LATENT:** Not apparent by reasonable inspection, including but not limited to, the inspections and research required as a condition to bidding under the General Conditions.
44. **MATERIAL OR MATERIALS:** These words shall be construed to embrace machinery, manufactured articles, materials of construction (fabricated or otherwise), and any other classes of material to be furnished in connection with Contract, except where a more limited meaning is indicated by context.
45. **MILESTONE:** A principal event specified in Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all Work.
46. **MODIFICATION:** Same as Contract Modification.
47. **NOT IN CONTRACT:** Work that is outside the scope of work to be performed by Contractor under this Contract.
48. **NOTICE OF AWARD:** A written notice given by CLPCCD to lowest responsive, responsible bidder advising that Bidder's bid and other qualifying information is acceptable to CLPCCD, requiring Bidder to fulfill the requirements of Article 1.03 of Document 00600 General Conditions.
49. **NOTICE TO PROCEED:** A written notice given by CLPCCD to Contractor fixing the date on which the Contract Time will commence to run and on which contractor shall start to perform Contractor's obligations under the Contract Documents.
50. **OFF SITE:** Outside geographical location of the Project.

51. **OWNER (DISTRICT):** Chabot Las Positas Community College District (CLPCCD).
52. **PROGRESS REPORT:** a periodic report submitted by Contractor to CLPCCD with progress payment invoices accompanying actual work accomplished to the Project Schedule. See Section 01310 Progress Schedules and Reports, Document 00600 General Conditions.
53. **PROJECT:** Total construction of which Work performed under this Contract may be whole or part.
54. **PROJECT MANUAL:** Project Manual consists of Bidding Requirements, Agreement, Bonds, Certificates, Contract Conditions, and Specifications. The Project Manual is deemed to include and incorporate all matters noted in any Addenda issued by or on behalf of the District during the bidding for the Work.
55. **PROJECT STABILIZATION AGREEMENT:** The Contractor or Subcontractor (CONTRACTOR) on this project accepts and agrees to be bound by the terms and conditions of the "Chabot-Las Positas Project Stabilization Agreement", together with any and all amendments and supplements now existing or which are later made by executing the Letter of Assent.
56. **PROVIDE:** Furnish and install.
57. **REQUEST FOR INFORMATION (RFI):** A document prepared by Contractor, CLPCCD or Architect/Engineer requesting information from one of the parties regarding the Project or Contract Documents. The RFI system is also a means for CLPCCD and Architect to submit Contract Document clarifications or supplements to Contractor.
58. **RFI-REPLY:** A document consisting of supplementary details, instructions or information issued by the Architect/Engineer, which clarifies or supplements Contract Documents and with which Contractor shall comply. RFI-Replies do not constitute changes in Contract Sum or Contract Times except as otherwise agreed in writing by CLPCCD. RFI-Replies will be issued through the RFI administrative system.
59. **SAMPLES:** Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
60. **SHOP DRAWINGS:** All drawings, diagrams, illustrations, schedules and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the work.
61. **SHOWN:** As indicated on Drawings.
62. **SITE:** The particular geographical location of Work performed pursuant to Contract, including staging areas, work areas, storage and lay down areas, access and parking.
63. **SPECIFICATIONS:** The written portion of the Contract Documents consisting of requirements for materials, equipment, construction systems, standards and workmanship for the Work, and performance of related services; and are contained in Divisions 1 through 32.
64. **SPECIFIED:** As written in Specifications.
65. **SUBCONTRACTOR:** A person or entity who has a direct contract with Contractor to perform a portion of the Work at the site. The term "subcontractor" is referred to throughout the Contract Documents as if singular in number and neuter in gender and means a subcontractor or an authorized representative of the subcontractor. The term "subcontractor" does not include a separate contractor or subcontractors of a separate contractor.
66. **SUBSTANTIAL COMPLETION:** The Work (or a specified part thereof) has progressed to the point where, in the opinion of the Construction Manager and the Architect/Engineer as evidenced by a Certificate of Substantial Completion, it is sufficiently complete, in accordance with Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended; or if no such certificate is issued, when the Work is complete and ready for final payment is evidenced by written recommendation of the Construction Manager and the Architect/Engineer for final payment. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.
67. **SUPPLEMENTAL INSTRUCTION:** A written work change directive to Contractor from Architect/Engineer, approved by Construction Manager, ordering alterations or modifications which do not result in change in Contract Sum or Contract Times, and do not substantially change Drawings or Specifications.
68. **UNDERGROUND FACILITIES:** All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: Electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems or water.
69. **VERIFIED REPORT:** A periodic verified report submitted to DSA. Refer to sections 4-336, 4-337 and 4-343, Part 1, Title 24, California Code of Regulations.

70. **WORK:** The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all is required by the Contract Documents. Wherever the word "work" is used, rather than the word "Work", it shall be understood to have its ordinary and customary meaning.
- B. Wherever words "as directed", "as required", "as permitted", or words of like effect are used, it shall be understood that direction, requirements, or permission of CLPCCD or Construction Manager is intended. Words "sufficient", "necessary", "proper", and the like shall mean sufficient, necessary or proper in judgment of CLPCCD or Construction Manager. Words "approved", "acceptable", "satisfactory", "favorably reviewed" or words of like import, shall mean approved by, or acceptable to, or satisfactory to, or favorably reviewed by CLPCCD or Construction Manager.
- C. Wherever the word "may" is used, the action to which it refers is discretionary. Wherever the word "shall" is used, the action to which it refers is mandatory.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 014500 - QUALITY CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Quality assurance and control of installation.
- B. References.
- C. Mock-Up.
- D. Inspection and testing laboratory services.
- E. Manufacturer's field services.

1.2 RELATED SECTIONS

- A. Submission of manufacturers' instructions and
- B. Sections requiring Laboratory Testing:
 - 1. Section 013300 - Submittals: certificates
 - 2. Division 31 - Earthwork

1.3 QUALITY ASSURANCE AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply fully with manufacturers' instructions, including each step in sequence.
- C. If manufacturers' instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform work by persons qualified to produce workmanship of specified quality.
- F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.4 REFERENCES

- A. Conform to reference standard by date of issue current on date specified in product sections.
- B. Should specified reference standards conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- C. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.5 **MOCK-UP**

- A. Mock-up and sample panels will be performed under various sections and identified as sample panels or mock-ups.
- B. Assemble and erect specified items with specified attachments, anchorage, flashing, seals and finishes.
- C. Where mock-up has been accepted by Architect/Engineer and is specified in product specification section to be removed, remove mock-up and clear area as directed.
- D. Whereas, mock-up submittals will be submitted until the acceptance by Architect/Engineer and Construction Manager.

1.6 **INSPECTION AND TESTING LABORATORY SERVICES**

- A. CLPCCD will appoint, employ and pay for services of an independent firm to perform inspection and testing.
- B. The independent firm will perform inspections, tests, and other services specified in individual specification sections and as required by the Architect/Engineer. Promptly notify Construction Manager, Architect/Engineer, DSA, Project Inspector, and Contractor of observed irregularities or deficiencies of work or products.
- C. Reports will be submitted by the independent firm, one copy each, to the Construction Manager, Architect, Engineer, Division of the State Architect, Contractor and Project Inspector. Indicate observations and results of tests and indicate compliance or non-compliance with Contract Documents and Title 24, C.C.R. specifically, each report will include the following:
 - 1. Date issued; date and time of sampling or inspection; date of test.
 - 2. Project title and number; testing laboratory name, address and telephone number; name and signature of laboratory inspector.
 - 3. Location of sampling or test; temperature and weather condition.
 - 4. Type of inspection or test; identification of product and specification section; results of test and compliance with Contract Documents and Title 24, C.C.R.
 - 5. Perform additional tests as required by Architect/Engineer and/or Project Inspector; interpret test results, when requested by Architect/Engineer.
 - 6. Special Inspections: as shown on attached Tests & Inspections (T&I) list for each section.
- D. Contractor shall cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.
 - 1. Notify Architect/Engineer 72 hours in advance and/or independent firm 24 hours prior to expected time for operations requiring services.
 - 2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.
 - 3. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the work of the contract.
- E. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Architect/Engineer and/or Project Inspector. Payment for retesting will be paid by the Contractor by deducting inspection or testing charges from the Contract Sum on the next scheduled payment.

1.7 **MANUFACTURER'S FIELD SERVICES**

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment as applicable, and to initiate instructions when necessary.

- B. Submit qualifications of observer to Construction Manager thirty (30) calendar days in advance of required observations. Observer shall be subject to approval of Construction Manager and Architect/Engineer.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- D. Refer to Section 013300 - Submittals: Manufacturers' Instructions.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 015000 - TEMPORARY FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the temporary facilities and controls required for the Project site during demolition and construction. The Project site shall be maintained by Contractor as set forth in this Section.

1.2 TEMPORARY FACILITIES

- A. Contractor shall obtain permits for, install and maintain in safe condition, whatever scaffolds, hoisting equipment, barricades, walkways, or other temporary structures, which may be required to accomplish the work on the Project. Contractor shall enclose and secure Project Site, including lay down area with a temporary chain link fence with site screen. Such structures shall be adequate for the intended use and capable of safely accepting all loads that may be imposed upon them. They shall be installed and maintained in accordance with all applicable State and local codes and regulations.
- B. Contractor shall provide and maintain temporary heat from an approved source whenever in the course of the Work it may become necessary for curing and drying of materials or to warm spaces as may be required for the installation of materials or finishes.
- C. Contractor shall provide and maintain any and all facilities that may be required for dewatering in order that work may proceed on the Project. If it is necessary for dewatering to occur continually, Contractor shall have on hand whatever spare parts or equipment that may be required to prevent interruption of dewatering.
- D. Contractor shall provide and maintain all utility services necessary to perform the work under this Contract. These may include, but are not limited to, temporary electricity, water, gas, sewer and telephone, including charges and installation fees. Contractor shall furnish and maintain all means of distribution of utility services required within the site to properly complete the Project.
- E. Materials, tools, accessories, etc., shall be stored only where directed by CLPCCD. Storage area shall be kept neat and clean. Security of stored items shall be Contractor's responsibility.
- F. When flammable materials are stored on site, extra precautions, including clear identification, shall be the responsibility of Contractor.
- G. Contractor shall provide and maintain temporary toilets in quantities and locations as required by CAL/OSHA and other local codes and regulations. They shall be maintained and supplied in a usable and sanitary condition at all times.
- H. If water at construction site is determined to be non-potable by Inspector, Contractor shall provide and maintain adequate potable water stations at site until final completion of the Project.
- I. Contractor shall maintain an office at the Project site, which will be his headquarters for the Project. Any communications delivered to this office shall be considered as delivered to Contractor. Location and size of office shall be such that it will adequately serve the needs of Contractor's superintendent and assistants in the performance of their duties.
- J. Contractor shall also provide and maintain the following temporary facilities for the duration of the project. Contractor shall obtain approval of the plans and specifications for all the following temporary facilities from Construction Manager prior to delivery to job site. Construction Manager shall have the option to reject said facilities if they do not meet Construction Manager's needs.
- K. Contractor shall promptly remove all such Temporary Facilities when they are no longer needed for the work or for completion of the Project, mutually agreed upon by Contractor and CLPCCD.

- L. Contractor shall provide and maintain in the Temporary Facilities a copy of the California Code of Regulations Title 24 (latest edition) Parts I & II.

1.3 SIGNS

- A. No signs may be displayed on or about CLPCCD's property (except those required by law) without CLPCCD's specific approval; the size, content, and location to be as specified by CLPCCD.
 - 1. Temporary Signs: Provide other signs as indicated and as required by law or ordinance to inform public and individuals seeking entrance to Project, and for directional egress signs from adjacent buildings.
 - a. Provide temporary, directional signs, and emergency signs for construction personnel and visitors, and other patrons of the adjacent facilities.
 - 2. Maintain and touch up signs, so they are legible at all times.

1.4 USE OF ROADWAYS AND WALKWAYS

- A. Contractor shall never block or interfere with use of any existing roadway, walkway or other facility for vehicular or pedestrian traffic, from any party entitled to use it. Wherever and whenever such interference becomes necessary for the proper and convenient performance of the Work, and no satisfactory detour route exists, Contractor shall, before beginning the interference, provide a satisfactory detour, including temporary bridge if necessary, or other proper facility for traffic to pass around or over the interference. Contractor shall maintain the detour in a safe and satisfactory condition as long as the interference continues, all without extra payment unless otherwise expressly stipulated in the Specifications.

PART 2 - PRODUCTS

2.1 TEMPORARY CONSTRUCTION AIDS AND EQUIPMENT

- A. General: Provide construction aids, equipment, and support facilities and controls as needed and as applicable to Increment under construction.
- B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide heavy, wind-resistant bases for supporting posts.
- C. Wood Enclosure Fence: Plywood, 8 feet high, unless otherwise indicated, framed with four 2-by-4-inch rails, with preservative-treated wood posts set on concrete footings spaced not more than 8 feet apart.
- D. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.
- E. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- F. HVAC Equipment: Unless District authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

3. Permanent HVAC System: If District authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."

PART 3 - EXECUTION

3.1 SUPPORT FACILITIES INSTALLATION

- A. General: Provide construction aids, equipment, and support facilities and controls as needed and as applicable to Increment under construction.
- B. Comply with the following:
 1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to District.
- C. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- D. Waste Disposal Facilities:
 1. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
 2. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017000 "Contract Closeout."
- E. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- F. Temporary Elevator Use: See Division 14 elevator Section for temporary use of new elevators.
- G. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- H. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.2 SITE ACCESS AND CONTROLS

- A. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- B. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.

2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Use parking areas designated by District for construction personnel.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Erosion and Sedimentation Control:
1. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
 - a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - b. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - c. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - d. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection:
1. Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- F. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
- G. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 2. Remove snow and ice as required to minimize accumulations.
- H. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction as needed to maintain security. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- K. Temporary Egress: Provide temporary egress from adjacent existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.4 MOISTURE AND MOLD CONTROL

- A. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- B. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.

4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard and replace stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- C. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Maintenance: Maintain protection measures in good operating condition during demolition and construction until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until directed by District.
- C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. District reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017000 "Contract Closeout."

END OF SECTION

SECTION 015639 – TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction or on adjacent properties.
- B. Related Sections:
 - 1. .
 - 2. Refer to Drawings for additional protection notes and identification of specific trees to be protected.

1.2 TREE PROTECTION PLAN

- A. A Tree Protection Plan shall be prepared by the Contractor in coordination with the project arborist. All project work will be conducted in accordance with the Tree Protection Plan.
- B. Ground-disturbing activities shall be conducted outside of the dripline of protected trees. When ground-disturbing activities (i.e., trenching, excavating) encounters roots smaller than two inches occurs outside of the dripline of protected trees, the roots shall be hand trimmed, making clear, clean cuts. All damaged, torn, and cut roots shall be given a clean cut to remove ragged edges, which promote decay.
- C. Trenches shall be filled within 24 hours, but, where, this is not possible, the side of the trench/excavation area adjacent to the protected trees shall be shaded with four layers of dampened, untreated burlap, wetted as frequently as necessary to keep the burlap wet.
- D. Roots two inches or larger, when encountered, shall be reported immediately to the Project Arborist, who shall decide whether the applicant may cut the roots as mentioned above or shall excavate by hand or with compressed air under the root. The root shall be protected with dampened burlap.
- E. In addition, the top two feet of the foundation closest to the protected trees shall be air spaded or hand dug under supervision of the Project Arborist to locate and evaluate any significant roots prior to mechanical excavation.
- F. Underground Utilities: To avoid conflict with roots, underground utilities shall be routed outside of an area, ten times the diameter of a protected tree. In addition, where it is not possible to reroute pipes or trenches, the utility shall be routed beneath the dripline, but as far away from the trunk as possible. The boring shall take place not less than three feet below the surface of the soil in order to avoid encountering feeder roots.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 016199 - MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Products
- B. Transportation and handling.
- C. Storage and protection.

1.2 RELATED SECTIONS

- A. Section 011100 - Summary of Work.
- B. Section 014500 - Quality Control: Product Quality Monitoring.
- C. Section 016200 - Product Options and Substitutions.

1.3 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work.
- B. Provide interchangeable components of the same manufacturer, for similar components.

1.4 TRANSPORTATION AND HANDLING

- A. Transport and handle products in accordance with manufacturer's instructions and construction schedules. Coordinate to avoid conflict with work and conditions at the site.
- B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.5 STORAGE AND PROTECTION

- A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.
- B. For exterior storage of fabricated products, place on sloped supports, above ground, to prevent soiling and staining.
- C. Provide off-site storage and protection when site does not permit on-site storage or protection.
- D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.
- E. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

- F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- G. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.
- H. Provide substantial covering and protection after installation of products from damage due to traffic and subsequent construction operations. Remove when no longer needed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 016200 - PRODUCT OPTIONS AND SUBSTITUTIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Procedures are described for selecting products and requesting substitutions of unlisted materials in lieu of materials named in the specifications or approved for use in addenda.
- B. Related Sections
 - 1. Section 012600: Contract Modification Procedures
 - 2. Section 013300: Submittal Procedures

1.2 CONTRACTOR'S OPTIONS

- A. For products specified only by reference standard: Select any product meeting that standard.
- B. For products specified by naming one or more products or manufacturers:
 - 1. Select products of any named manufacturer meeting specifications.
 - 2. For any product or manufacturer, which is not specifically named, submit Request for Substitution (RFS).
- C. For products indicated or specified by naming only one product and manufacturer, followed by the words "no substitution allowed", there is no option.

1.3 SUBSTITUTIONS

- A. No substitutions shall be allowed for District standard systems, products, and/or materials unless approved in writing from the Architect's office five (5) days prior to bid. The entire District Standard systems, products, and/or materials can be found on the District's website at:

<http://www.clpccd.org/facilities/DistrictStandardsandGuidelines-ChabotCollege.php>

- B. Within a period of thirty-five (35) days after Award of Contract, Construction Manager and Architect/Engineer will consider RFS from Contractor. After that period, requests will be considered only when product becomes unavailable due to no fault of Contractor. Requests for review of proposed substitute items will not be accepted from anyone other than Contractor. The RFS will state the extent, if any, to which the evaluation and acceptance of the proposed substitute will prejudice Contractor's achievement of substantial completion on time, whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with CLPCCD for work on the Project).
- C. Submit separate RFS for each product and support each request with:
 - 1. Product identification
 - 2. Manufacturer's literature
 - 3. Samples, as applicable
 - 4. Name and address of similar projects on which product has been used, and date of installation
 - 5. Name, address and telephone number of manufacturer's representative or sales engineer
 - 6. Where DSA approval is required, product shall be reviewed and approved by DSA
- D. Itemize a comparison of the proposed substitution with product specified and list significant variations. If variation from product specified is not pointed out in submittal, variation will be rejected even though submittal was favorably reviewed.

- E. State whether the substitute will require a change in any of the Contract documents (or provisions of any other direct contract with CLPCCD for work on the Project) to adapt the design of the proposed substitute, and whether or not incorporation or use of the substitute in connection with Work is subject to payment of any license fee or royalty. Submit data relating to changes in construction schedule.
- F. All variations of the proposed substitute from that specified will be identified in the RFS and available maintenance, repair and replacement service will be indicated.
- G. Include accurate cost data comparing proposed substitution with product and amount of net change in Contract price, including but not limited to, an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors effected by the resulting change, all of which will be considered by Construction Manager and Architect/Engineer in evaluating the proposed substitute. Construction Manager and Architect/Engineer may require Contractor to furnish additional data about the proposed substitute.
- H. Substitutions will not be considered for acceptance when:
 - 1. They will result in delay meeting construction milestones or completion dates.
 - 2. Substitution of products results in an increase in costs resulting in a additional cost change order to the District
 - 3. They are indicated or implied on submittals without formal request from Contractor.
 - 4. They are requested directly by subcontractor or supplier.
 - 5. Acceptance will require substantial revision of Contract Documents.
 - 6. They disrupt Contractor's job rhythm or ability to perform efficiently.
- I. Substitute products shall not be ordered without written acceptance of Construction Manager and Architect/Engineer.
- J. Construction Manager and Architect/Engineer will determine acceptability of proposed substitutions and reserve right to reject proposals due to insufficient information.
- K. Accepted substitutions will be evidenced by a change order or Supplemental Instruction. All Contract requirements apply to Work involving substitutions.

1.4 CONTRACTOR'S REPRESENTATION AND WARRANTY

- A. Requests constitute a representation and warranty that Contractor:
 - 1. Has investigated proposed product and determined that it meets or exceeds, in all respects, specified product
 - 2. Will provide the same warranty for substitution as for specified product
 - 3. Will coordinate installation and make other changes, which may be required for Work to be complete in all respects
 - 4. Waives claims for additional costs, which may subsequently become apparent
 - 5. Will compensate CLPCCD for additional redesign costs associated with substitution, if required
 - 6. Will be responsible for Construction Schedule slippage due to substitution
 - 7. Will be responsible for Construction Schedule delay due to late ordering of available specified products caused by requests for substitution, which is subsequently rejected by Construction Manager
 - 8. Will compensate CLPCCD for all costs; including extra costs of Contract, extra cost to other contractors, and any claims brought against CLPCCD, caused by late requests for substitutions or late ordering of products.

1.5 CONSTRUCTION MANAGER'S AND ARCHITECT/ENGINEER'S DUTIES

- A. Review Contractor's RFS within seven (7) working days.

- B. Notify Contractor in writing of decision to accept or reject requested substitution within seven (7) working days.

1.6 COST OF REVIEW

- A. Construction Manager and Engineer will record time required in evaluating substitutes proposed or submitted by Contractor. Whether or not Construction Manager or Architect/Engineer accepts the substitute item so proposed or submitted by Contractor, Contractor shall reimburse CLPCCD for the charges of Architect/Engineer and Construction Manager for evaluating each such proposed substitute item.
- B. The CLPCCD reserves the right to waive the requirement of paragraph A above.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected," Architect will make selection.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 - 6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," or "or approved comparable product," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect through Construction Manager in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Architect, whose determination is final.
- B. Product Selection Procedures: The following language is used in the specifications to indicate how products may be selected:
 - 1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
 - 2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
 - 3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

- a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
 4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
 - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
 5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
 6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
 7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
 8. Reference Standards: Where Specifications describe a product by referring to a reference standard without listing product/manufacturer, propose a product that meets the standard. Where additional product description modifies the reference standard, propose a product that meets the standard as modified.
- C. Product Uniformity: It is the intent of the documents that the completed construction be uniform through-out the Project. For each type of product, the manufacturer and model shall not vary. After a particular product has been identified and approved for an application, that product shall be used for that application across all the subcontracts and other Work related contracts held by the Contractor. This provision applies equally to accepted substitutions.
- D. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- E. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

- F. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 sustainability requirements Section and individual Specification Sections.
1. Select products for which sustainable design documentation submittals are available from manufacturer.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:
1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.
 6. By proposing a product that is not listed, for consideration as a comparable product, the Contractor affirms that it meets requirements, except where clearly indicated otherwise. Approval, if granted, will be contingent upon the product meeting requirements as a comparable product. In the absence of clear indication of non-compliance in product submittal, approval of the comparable product by Architect will be based on Contractor's affirmation, whether explicit or implicit.
- B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for a comparable product. Architect will notify Contractor through Construction Manager of approval or rejection of proposed comparable product within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
1. Architect's Approval of Submittal: Indication of approval in web-based Project management software. See Section 013300 "Submittal Procedures."
 2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- C. Submittal Requirements, Two-Step Process: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 017000 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes contract closeout procedures including:
 - 1. Removal of temporary construction facilities
 - 2. Substantial completion
 - 3. Final completion
 - 4. Final cleaning
 - 5. Material, equipment and finish data
 - 6. Project guarantee
 - 7. Warranties
 - 8. Turn-in
 - 9. Release of claims
 - 10. Guaranty and Maintenance Bonds

- B. Related Requirements:
 - 1. Section 017800 - Project Record Documents

1.2 REMOVAL OF TEMPORARY CONSTRUCTION FACILITIES

- A. Remove temporary materials, equipment, services, and construction prior to Substantial Completion Inspection.
- B. Clean and repair damage caused by installation or use of temporary facilities.
- C. Restore permanent facilities used during construction to specified condition.

1.3 SUBSTANTIAL COMPLETION

- A. When Contractor considers Work or designated portion thereof as substantially complete, submit written notice, with list of items to be completed or corrected to Construction Manager.
- B. Within reasonable time, Construction Manager and Architect/Engineer will inspect to determine status of completion.
- C. Should Construction Manager or Architect/Engineer determine that Work is not substantially complete; Construction Manager will promptly notify Contractor in writing, listing all defects and omissions.
- D. Remedy deficiencies and send a second written notice of substantial completion. Architect/Engineer will reinspect the Work. If deficiencies previously noted are not corrected on reinspection, then Contractor shall pay the cost of the reinspection.
- E. When Architect/Engineer determines that Work is substantially complete, Construction Manager will issue a Certificate of Substantial Completion.
- F. Manufactured units, equipment and systems, which require startup, must have been started up and run for periods prescribed by Construction Manager, Architect/Engineer, or Owner before a Certificate of Substantial Completion will be issued.

1.4 FINAL COMPLETION

- A. When Contractor considers Work is complete, submit written certification that:

1. Contractor has inspected Work for compliance with Contract Documents.
2. Work, except for Contractor maintenance after Final Acceptance, has been completed in accordance with Contract Documents and deficiencies listed with Certificate of Substantial Completion have been corrected.
3. Work is complete and ready for final inspection.
4. Contractor has achieved all requirements for Final Acceptance as that term is defined in Section 014100 – Regulatory Requirements.
 - a. In addition to submittals required by conditions of Contract, provide submittals required by governing authorities and submit final statement of accounting giving total adjusted Contract Sum, previous payments, and sum remaining due.
 - b. When Architect/Engineer finds Work is acceptable and final submittal is complete, Construction Manager will issue final change order reflecting approved adjustments to Contract Sum not previously made by Change Order.

1.5 FINAL CLEANING

- A. Execute final cleaning prior to final inspection.
- B. Clean interior and exterior surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
 1. Clean equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment operated during construction, clean ducts, blowers and coils of units operated without filters during construction.
 2. Employ skilled workers for final cleaning.
 - a. Clean Site; mechanically sweep-paved areas.
 - b. Remove waste and surplus materials, rubbish, and construction facilities from Site.

1.6 PROJECT RECORD DOCUMENTS

- A. General: Refer to Section 017800 - Project Record Documents.

1.7 PROJECT GUARANTEE

- A. Neither recordation of final acceptance nor final certificate for neither payment nor provision of the Contract nor partial or entire use or occupancy of the Site by CLPCCD shall constitute acceptance of Work not done in accordance with Contract Documents nor relieve Contractor of liability in respect to express warranties or responsibility for faulty materials or workmanship.
- B. Requirements for Contractor's guarantee of completed Work are included in General Conditions, Article 1.09. Contractor shall guarantee Work done under Contract against failures, leaks or breaks or other unsatisfactory conditions due to defective equipment, materials or workmanship, and perform repair work or replacement required, at Contractor's sole expense, for period of 1 year from date of Final Acceptance, as required by paragraph 13.2 of General Conditions.
- C. CLPCCD may make repairs to defective Work as set forth in paragraph 12.6 of General Conditions, if, within 5 working days after mailing of written notice of defective work to Contractor or authorized agent, Contractor shall neglect to make or undertake with due diligence repairs; provided, however, that in case of leak or emergency where, in opinion of CLPCCD, delay would cause hazard to health or serious loss or damage, repairs may be made without notice being sent to Contractor, and Contractor shall pay cost thereof.
- D. If, after installation, operation or use of materials or equipment to be furnished under Contract proves to be unsatisfactory to Construction Manager, CLPCCD shall have right to operate and use materials or equipment until it can, without damage to CLPCCD, be taken out of service for correction or replacement. Period of use of defective materials or equipment pending correction or replacement shall in no way decrease guarantee period required for acceptable corrected or replaced items of materials or equipment.

- E. Nothing in this Section shall be construed to limit, relieve or release Contractor's, subcontractors' and equipment suppliers' liability to CLPCCD for damages sustained as result of latent defects in equipment caused by negligence of suppliers' agents, employees or subcontractors. Stated in another manner, warranty contained in the Contract Documents shall not amount to, nor shall it be deemed to be, waiver by CLPCCD of any rights or remedies (or time limits in which to enforce such rights or remedies) it may have for defective workmanship or defective materials under laws of this State pertaining to acts of negligence.

1.8 WARRANTIES AND BONDS

- A. Execute Contractor's submittals and assemble documents executed by subcontractors, suppliers, and manufacturers.
 - 1. Provide table of contents and assemble in 8-1/2 inches by 11 inches three-ring binder with durable plastic cover.
 - 2. Assemble in Specification Section order.
 - 3. Provide an electronic copy of all warranties on thumb drive in PDF format
 - a. Submit material prior to final application for payment.
- B. For equipment put into use with CLPCCD's permission during construction, submit within ten (10) working days after first operation.
- C. For items of Work delayed materially beyond Date of Substantial Completion, provide updated submittal within ten (10) working days after acceptance, listing date of acceptance as start of warranty period.
- D. Warranties are intended to protect CLPCCD against failure of work and against deficient, defective and faulty materials and workmanship, regardless of sources.
- E. Limitations: Warranties are not intended to cover failures, which result from the following:
- F. Unusual or abnormal phenomena of the elements
- G. Vandalism after substantial completion
- H. Insurrection or acts of aggression including war
- I. Related Damages and Losses: Remove and replace Work which is damaged as result of defective Work, or which must be removed and replaced to provide access for correction of warranted Work.
- J. Warranty Reinstatement: After correction of warranted Work, reinstate warranty for corrected Work to date of original warranty expiration or to a date not less than 365 days after corrected Work was done, whichever is later.
- K. Replacement Cost: Replace or restore failing warranted items without regard to anticipated useful service lives.
- L. Warranty Forms: Submit drafts to Construction Manager for approval prior to execution. Forms shall not detract from or confuse requirements or interpretations of Contract Documents.
- M. Warranty shall be countersigned by manufacturers.
- N. Where specified, warranty shall be countersigned by subcontractors and installers.
- O. Rejection of Warranties: CLPCCD reserves right to reject unsolicited and coincidental product warranties, which detract from or confuse requirements or interpretations of Contract Documents.

- P. Term of Warranties: For materials, equipment, systems and workmanship warranty period shall be two (2) years minimum from date of substantial completion of entire Work except where:
1. Detailed specifications for certain materials, equipment or systems require longer warranty periods.
 2. Materials, equipment or systems are put into beneficial use of CLPCCD prior to Substantial Completion as agreed to in writing by Construction Manager.
- Q. Warranty of Title: No material, supplies, or equipment for Work under Contract shall be purchased subject to any chattel mortgage, security agreement, or under a conditional sale or other agreement by which an interest therein or any part thereof is retained by seller or supplier. Contractor warrants good title to all material, supplies, and equipment installed or incorporated in Work and agrees upon completion of all work to deliver the Site, together with improvements and appurtenances constructed or placed thereon by Contractor, to CLPCCD free from any claim, liens, security interest, or charges, and further agrees that neither Contractor nor any person, firm, or corporation furnishing any materials or labor for any Work covered by Contract shall have right to lien upon the Site or improvement or appurtenances thereon. Nothing contained in this Paragraph, however, shall defeat or impair right of persons furnishing materials or labor under bond given by Contractor for their protection or any rights under law permitting persons to look to funds due Contractor in hands of CLPCCD.

1.9 TURN-IN

- A. Contract will not be closed out and final payment will not be made until all personnel Identification Media, vehicle permits and keys issued to Contractor during prosecution of Work are turned in to CLPCCD.

1.10 RELEASE OF CLAIMS

- A. Contract will not be closed out and final payment will not be made until Contract Agreement and Release of Any and All Claims, is completed and executed by Contractor and CLPCCD.

1.11 FIRE INSPECTION COORDINATION

- A. Contractor shall coordinate fire inspection and secure sufficient notice to CLPCCD to permit convenient scheduling.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 017329 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Included: This Section establishes general requirements pertaining to cutting, fitting, and patching of the work required to:
1. Make the several parts fit properly.
 2. Uncover work to provide for installation, inspection, or both of ill-timed work.
 3. Remove and replace work not conforming to requirements of the Contract Documents.
 4. Remove and replace defective work.

1.2 QUALITY ASSURANCE

- A. Perform all cutting and patching in accordance with pertinent requirements of the specifications and in the event no such requirements are determined, in conformance with the Architect's written direction. In the absence of either of the previous, the work shall be completed as a minimum to industry standards for the given scope and project.
- B. In all cases, exercise extreme care in cutting operations and perform such operations under adequate supervision by competent mechanics skilled in the applicable trade. Openings shall be neatly cut and shall be kept as small as possible to avoid unnecessary damage. Careless and/or avoidable cutting damage, etc., will not be tolerated, and the Contractor will be held responsible for such avoidable or willful damage.
- C. All replacing, patching, and repairing of materials and surfaces cut or damaged in the execution of the work shall be performed by experienced mechanics of the several trades involved. Such replacing, repairing, and/or patching shall be done with the applicable materials, in such a manner that all surfaces so replaced, etc., will upon completion of the work, match the surrounding similar surfaces.

1.3 SUBMITTALS

- A. Request for the Architect's Consent:
1. Prior to cutting which affects structural safety, submit a written request to the Architect for permission to proceed with cutting.
 2. Should conditions of the work, or schedule, indicate a required change of materials or methods for cutting and patching, notify the Architect and secure his written permission prior to proceeding.
- B. Notices to the Architect:
1. Submit written notice to the Architect designating the time the work will be uncovered, therefore providing a time for the Architect's observation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. For replacement of work removed, use materials which comply with the pertinent Section of these specifications. If materials are not covered within these documents, products and methods shall be provided and installed to match existing conditions.

2.2 CUTTING AND PATCHING

- A. Employ skilled and experienced installer to perform cutting and patching.

- B. Submit written request in advance of cutting or altering elements, which affects:
 - 1. Structural integrity of element.
 - 2. Integrity of weather-exposed or moisture-resistant elements.
 - 3. Efficiency, maintenance, or safety of element.
 - 4. Visual qualities of sight-exposed elements.
- C. Execute cutting, fitting, and patching including excavation and fill, to complete Work, and to:
 - 1. Fit the several parts together, to integrate with other Work.
 - 2. Uncover Work to install or correct ill-timed work.
 - 3. Remove and replace defective and non-conforming Work.
 - 4. Remove samples of installed Work for testing.
 - 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- D. Execute work by methods, which will avoid damage to other Work, and provide proper surfaces to receive patching and finishing.
- E. Cut rigid materials using masonry saw or core drill.
- F. Restore Work with new products in accordance with requirements of Contract Document.
- G. Fit Work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- I. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.
- J. Identify any hazardous substance or condition exposed during the Work to the Architect for decision or remedy.

PART 3 - EXECUTION

3.1 CONDITIONS

- A. Inspect existing conditions, including elements subject to movement or damage during cutting and patching.
- B. After uncovering the work, inspect conditions affecting installation of new work.

3.2 DISCREPANCIES

- A. If uncovered conditions are not as anticipated, immediately notify the Architect through the Construction Manager and secure needed directions.
- B. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.3 PREPARATION PRIOR TO CUTTING

- A. Provide all required protection including, but not necessarily limited to, shoring, bracing, and support to maintain structural integrity of the work.

3.4 PERFORMANCE

- A. Perform cutting and demolition by methods which will prevent damage to other portions of the work and will provide a proper surface to receive new installation or repair and new work. Perform fitting and adjustment of products to provide finished installation complying with the specified tolerance and finishes.

END OF SECTION

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Recycling nonhazardous demolition and construction waste.
 - 2. Disposing of nonhazardous demolition and construction waste.
- B. In an effort to keep astemanagemtn and disposal requiements consistent for entire Project, rather than by individual Increment, reveiw and address issues as appliable to each Increment. Project closeout shall accumulate all data and submittals required to achieve approval.

1.2 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

1.4 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 7 days of date established for the Notice to Proceed.

1.5 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use the LEED v4 Construction and Demolition Waste Calculator (can be downloaded here: <https://www.usgbc.org/resources/construction-and-demolition-waste-calculator>). Include the following information:
 - 1. Material Description, material type, and material waste stream.
 - 2. Generation point of waste.
 - 3. Total quantity of waste in tons.
 - 4. Quantity of diverted (salvaged, recycled) from landfills, in both estimated and actual volumes or weights.
 - 5. Quantity of sent to landfill, in either estimated volumes and actual volumes or weights
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. LEED Submittal: Submit documentation to USGBC, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met. Respond to questions and requests from USGBC regarding construction waste management and disposal until the USGBC has made its determination on the project's LEED certification application. Document correspondence with USGBC as informational submittals.
- H. Qualification Data: For waste management coordinator and refrigerant recovery technician.
- I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- J. Refrigerant Recovery: Comply with requirements in Section 024100 "General Demolition Procedures" for refrigerant recovery submittals.

1.6 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent may serve as Waste Management Coordinator.
 - 1. Firm employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator.
 - 2. Waste management coordinator may also serve as LEED coordinator.
- B. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.
- C. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013119 "Project Meetings." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
 - 2. Review requirements for documenting quantities of each type of waste and its disposition.
 - 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 - 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 - 5. Review waste management requirements for each trade.

1.7 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

- B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Use LEED v4 or v4.1 Construction and Demolition Waste Calculator. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use LEED v4 or v4.1 Construction and Demolition Waste Calculator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with Section 024116 "Structure Demolition."
 - 2. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 - 3. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 - 4. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Develop diverted materials system to include at least four material streams. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities."
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned within 7 days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
 - 2. Comply with Section 015000 "Temporary Facilities" for controlling dust and dirt, environmental protection, and noise control.

3.2 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.3 RECYCLING DEMOLITION WASTE

- A. General: As applicable to each Increment.
- B. Asphalt Paving: Grind asphalt to maximum 1-1/2-inch size.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 - 1. Pulverize concrete to maximum 1-1/2-inch size.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 - 1. Pulverize masonry to maximum 1-1/2-inch size.
 - 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- F. Metals: Separate metals by type.
 - 1. Structural Steel: Stack members according to size, type of member, and length.
 - 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- H. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- I. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.
- J. Carpet: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- K. Carpet Tile: Remove debris, trash, and adhesive.
 1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- L. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.
- M. Conduit: Reduce conduit to straight lengths and store by material and size.
- N. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.4 RECYCLING CONSTRUCTION WASTE

- A. General: As applicable to each Increment.
- B. Packaging:
 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 2. Polystyrene Packaging: Separate and bag materials.
 3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
 4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- C. Wood Materials:
 1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
 2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
- D. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.
 1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
 - a. Comply with requirements in Section 329300 "Plants" for use of clean ground gypsum board as inorganic soil amendment.
- E. Paint: Seal containers and store by type.

3.5 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.

END OF SECTION 017419

SECTION 017800 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Administrative and procedural requirements for Project Record Documents.
- B. Project Record Documents required include:
 - 1. Marked-up copies of Drawings
 - 2. Marked-up copies of Shop Drawings
 - 3. Newly prepared Drawings
 - 4. Marked-up copies of Specifications, Addenda, Change Orders and CCDs
 - 5. Marked-up Product Data submittals
 - 6. Record Samples
 - 7. Field records for variable and concealed conditions
 - 8. Record information on Work that is recorded only schematically
 - 9. Maintenance forms for major equipment
 - 10. Comments to all required DSA documentation
 - 11. All approved change orders
- C. Specific Project Record Documents requirements that expand requirements of this Section are included in the individual Sections of Divisions 2 through 33.
- D. General Project closeout requirements are included in Section 017000:Contract Closeout.
- E. Maintenance of Documents and Samples:
 - 1. Store Project Record Documents and Samples in the field office apart from Contract Documents used for construction.
 - 2. Do not permit Project Record Documents to be used for construction purposes.
 - 3. Maintain Project Record Documents in good order and in a clean, dry, legible condition.
 - 4. Make Documents and Samples available at all times for inspection by District.
- F. District will provide one full size blue line set of the Drawings and one Project Manual for Contractor's use for recording as-built conditions.

1.2 PROJECT RECORD DRAWINGS

- A. Mark-up Procedure: During the construction period, maintain a set of blue line or black line prints of Contract Drawings and Shop Drawings for Project Record Documents purposes. Label each document (on first sheet or format page) "PROJECT RECORD" in 2-inch high printed letters. Keep record documents current as Project proceeds. Note: A reference by number to a Change Order, Supplemental Instructions, RFI, RFQ, RFP, Field Order or other such document is not acceptable as sufficient record information on any record document. Do not permanently conceal any Work until required information has been recorded.
 - 1. Mark these Drawings to indicate the actual installation where the installation varies appreciably from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include but are not limited to:
 - a. Dimensional changes to the Drawings
 - b. Revisions to details shown on the Drawings
 - c. Depths of various elements of foundation in relation to main floor level or survey datum
 - d. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements

- e. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure
 - f. Locations of underground work, points of connection with existing utilities, changes in direction, valves, manholes, catch basins, capped stub outs, invert elevations, and similar items
 - g. Actual numbering of each electrical circuit
 - h. Field changes of dimension and detail
 - i. Revisions to routing of piping and conduits
 - j. Revisions to electrical circuitry
 - k. Actual equipment locations
 - l. Duct size and routing
 - m. Changes made by Change Order or Supplemental Instruction
 - n. Details not on original Contract Drawings
2. Mark completely and accurately Project Record Drawing prints of Contract Drawings or Shop Drawings, whichever is the most capable of showing actual physical conditions. Where Shop Drawings are marked, show cross-reference on Contract Drawings location.
 3. Mark Project Record Drawing sets with red, erasable colored pencil; use other colors to distinguish between changes for different categories of the Work at the same location.
 4. Mark important additional information that was either shown schematically or omitted from original Drawings.
 5. Note Supplemental Instructions numbers, alternate numbers, Change Order numbers, and similar identification.
 6. Responsibility for Mark-up: Where feasible, the individual or entity who obtained Project Record Drawing data, whether the individual or entity is the installer, Subcontractor, or similar entity, is required to prepare the mark-up on Project Record Drawings.
 - a. Accurately record information in an understandable and legible drawing technique.
 - b. Record data as soon as possible after it has been obtained. In the case of concealed installations, record and check the mark-up prior to concealment.
- B. Preparation of Record Drawings: Immediately prior to inspection for Certification of Substantial Completion, review completed marked-up Project Record Drawings with District and Architect/Engineer. When authorized, prepare a full set of corrected digital data files of Contract Drawings.
1. Prior to Substantial Completion of the Work, Architect will make available to Contractor originals of the Contract Drawings, in AutoCAD 2024, .DWG format, for use in recording information.
 - a. Architect will provide data file layer information. Record markups in separate layers.
 2. Incorporate changes and additional information previously marked on print sets. Erase, redraw, and add details and notations where applicable. Identify and date each Drawing: include the printed designation "PROJECT RECORD DRAWING" in a prominent location on each Drawing.
 3. Refer instances of uncertainty to District for resolution.
 4. Clearly indicate at each affected detail and other drawings a full description of changes made during construction, and the actual location of items as previously specified.
 5. "Cloud" all affected areas.
 6. Stamp each Record Drawing with the following information:
 - a. Project Record Document.
 - b. Prepared by: Contractor's name, permanent address.
 - c. Date prepared.
 - d. Contractor's signature.
 - e. District Contract Number.
 - f. DSA Application #
- C. Review of Documents: Before copying and distributing final documents, submit one plot of corrected Project Record Drawings and the original marked-up prints to the Architect/Engineer for review. When acceptable, the Architect/Engineer will initial and date each document, indicating acceptance of general scope of changes and additional information recorded, and of the quality of drafting.
1. Documents and the original marked-up prints will be returned to the Contractor for organizing into sets, printing, binding, and final submittal.

- D. Copies and Distribution: After completing the preparation of Project Record Drawings and final review by Architect, submit the the following to District for District's records, whether or not changes and additional information were recorded:
 - 1. One digital data file set in original drawing format,
 - 2. one full size blue-line or black-line plots of each Drawing set,
 - 3. one half size blue-line or black-line plots of each Drawing set,
 - 4. and the marked-up Project Record Drawings set.
- E. Organize the copies into manageable sets. Bind each set with durable paper cover sheets, with appropriate identification, including titles, dates and other information on cover sheets.
 - 1. Organize and bind original marked-up set of prints that were maintained during the construction period in the same manner.
 - 2. Organize Project Record Drawings into sets matching the print sets. Place these sets in durable tube-type drawing containers with end caps. Mark the end cap of each container with suitable identification.
- F. Shop Drawings and Samples: Maintain as record documents; legibly annotate Shop Drawings and Samples to record changes made after review.
- G. In addition to requirements of this Section, comply with supplemental requirements of Divisions 21 through 28, as applicable.
 - 1. Divisions 21 though 28 of the Specifications may require the preparation of large scale, detailed layout drawings of the Work of those Divisions. These layout drawings are not Shop Drawings as defined by General Conditions, but together with Shop Drawings or layout drawings of all other affected Sections are used to check, coordinate, and integrate the work of the various Sections.
 - 2. Include these layout drawings as part of the Project Record Documents.

1.3 PROJECT RECORD SPECIFICATIONS

- A. During the construction period, maintain one copy of the Project Specifications, including addenda and modifications issued, for Project Record Documents purposes.
 - 1. Mark the Project Record Specifications to indicate the actual installation where the installation varies substantially from that indicated in Specifications and Modifications issued. Note related Project Record Drawing information, where applicable. Give particular attention to substitutions, selection of product options, Change Order and Supplemental Instruction work, and information on concealed installation that would be difficult to identify or measure and record later.
 - a. In each Specification Section where products, materials or units of equipment are specified or scheduled, mark the copy with the proprietary name and model number of the product furnished.
 - b. Record the name of the manufacturer, catalog number, supplier and installer, and other information necessary to provide a record of selections made and to document coordination with Project Record Product Data submittals and maintenance manuals.
 - c. Note related Project Record Product Data, where applicable, for each principal product specified, indicate whether Project Record Product Data has been submitted in maintenance manual instead of submitted as Project Record Product Data.
 - 2. Upon completion of mark-up, submit Project Record Specifications to District for District's records.
 - a. Submit Project Record Specifications as annotated PDF electronic file on compact disc (CD or DVD), and one paper copy.

1.4 PROJECT RECORD PRODUCT DATA

- A. During the construction period, maintain one copy of each Project Record Product Data submittal for Project Record Document purposes.

1. Mark Project Record Product Data to indicate the actual product installation where the installation varies substantially from that indicated in Project Record Product Data submitted. Include significant changes in the product delivered to the Site, and changes in manufacturer's instructions and recommendations for installation.
2. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
3. Note related Change Orders and mark-up of Project Record Drawings, where applicable.
4. Upon completion of mark-up, submit a complete set of Project Record Product Data to District for District's records.
5. Where Project Record Product Data is required as part of maintenance manuals, submit marked-up Project Record Product Data as an insert in the manual, instead of submittal as Project Record Product Data.
6. Contractor is responsible for mark-up and submittal of Project Record Product Data for its own Work.
7. Upon completion of mark-up, submit Project Record Product Data to District for District's records.
 - a. Submit Project Record Product Data as annotated PDF electronic file on compact disc (CD or DVD), and one paper copy.

1.5 MATERIAL, EQUIPMENT AND FINISH DATA

- A. Provide data for primary materials, equipment and finishes as required under each Specification Section.
- B. Submit three (3) hard copy sets and one annotated (1) digital copy, on compact disc (CD or DVD) prior to final inspection, bound in 8-1/2 inches by 11 inches three-ring binders with durable plastic covers; provide typewritten table of contents for each volume.
- C. Arrange by Specification Section number and give names, addresses, and telephone numbers of Subcontractors and suppliers. List:
 1. Trade names.
 2. Model or type numbers.
 3. Assembly diagrams.
 4. Operating instructions.
 5. Cleaning instructions.
 6. Maintenance instructions.
 7. Recommended spare parts.
 8. Product data.

1.6 MISCELLANEOUS PROJECT RECORD SUBMITTALS

- A. Refer to other Specification Sections for miscellaneous record keeping requirements and submittals in connection with various construction activities. Immediately prior to Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Submit to the District for District's records. Categories of requirements resulting in miscellaneous records include, but are not limited to, the following:
 1. Field records on excavations and foundations
 2. Field records on underground construction and similar work
 3. Survey showing locations and elevations of underground lines
 4. Invert elevations of drainage piping
 5. Surveys establishing building lines and levels
 6. Authorized measurements utilizing unit prices or allowances
 7. Records of plant treatment
 8. Ambient and substrate condition tests
 9. Certifications received in lieu of labels on bulk products
 10. Batch mixing and bulk delivery records
 11. Testing and qualification of tradespersons
 12. Documented qualification of installation firms
 13. Load and performance testing

14. Inspections and certifications by governing authorities
15. Leakage and water-penetration tests
16. Fire resistance and flame spread test results
17. Final inspection and correction procedures
18. Final As-Built Construction Schedule

1.7 ADDITIONAL REQUIREMENTS FOR FINAL PROJECT RECORD DOCUMENTS

- A. Stamp each Record Document with the following information:
 1. Project Record Document.
 2. Prepared by: Contractor's name, permanent address.
 3. Date prepared.
 4. Contractor's signature.
 5. District Contract Number.
 6. DSA Application #
- B. For electronic files:
 1. Do not check the "read only" option
 2. Do not password protect any files

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 RECORDING

- A. Post changes and modifications to the Contract Documents as they occur. Do not wait until the end of the Project. District may periodically review Project Record Documents to assure compliance with this requirement.

3.2 SUBMITTAL

- A. At completion of Project, deliver Project Record Documents to District.
- B. Accompany submittal with transmittal letter containing:
 1. Date
 2. Project title and number
 3. Contractor's name and address
 4. Number and title of each Project Record Document
 5. Certification that each document as submitted is complete and accurate, and signature of Contractor or Contractor's authorized representative.

END OF SECTION

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.2 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.
 - 2. Submit three paper copies. Architect will return two copies.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.
 - 1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.
- E. Submit operation and maintenance documentation a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion.

1.4 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, post-type binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.5 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.

5. Name and contact information for Contractor.
 6. Name and contact information for Construction Manager.
 7. Name and contact information for Architect.
 8. Name and contact information for Commissioning Authority.
 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation in accordance with to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.7 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.

- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
 - 1. Instructions on stopping.
 - 2. Shutdown instructions for each type of emergency.
 - 3. Operating instructions for conditions outside normal operating limits.
 - 4. Required sequences for electric or electronic systems.
 - 5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Performance and design criteria if Contractor has delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. Operating logs.
 - 6. Wiring diagrams.
 - 7. Control diagrams.
 - 8. Piped system diagrams.
 - 9. Precautions against improper use.
 - 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.
 - 2. Manufacturer's name.
 - 3. Equipment identification with serial number of each component.
 - 4. Equipment function.
 - 5. Operating characteristics.
 - 6. Limiting conditions.
 - 7. Performance curves.
 - 8. Engineering data and tests.
 - 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.

9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
 - 2. Demonstration and training video recordings.

1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For facilitator, instructor and videographer.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Date of video recording.
 - 2. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
 - 3. At completion of training, submit complete training manual(s) for Owner's use prepared in same PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, experienced in operation and maintenance procedures and training.

- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013119 "Project Meetings." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 - 1. Inspect and discuss locations and other facilities required for instruction.
 - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 - 3. Review required content of instruction.
 - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.6 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Systems and equipment operation manuals.
 - c. Systems and equipment maintenance manuals.
 - d. Product maintenance manuals.
 - e. Project Record Documents.
 - f. Identification systems.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.

- c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
- a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

1.7 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

1.8 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner, through Construction Manager, with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
- F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.9 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode with vibration reduction technology.
 - 1. Submit video recordings by uploading to web-based Project software site.
 - 2. File Hierarchy: Organize folder structure and file locations in accordance with Project Manual table of contents. Provide complete screen-based menu.
 - 3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
 - 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged in accordance with Project Manual table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. Email address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
 - 1. Film training session(s) in segments not to exceed 15 minutes.
 - a. Produce segments to present a single significant piece of equipment per segment.
 - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
 - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
 - 1. Furnish additional portable lighting as required.

- E. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017900

SECTION 018113.15 - SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 BD+C

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements and procedures for compliance with certain prerequisites and credits needed for Project to obtain minimum "LEED Version 4.0 for New Construction" (LEED v4.0 NC) **Silver** certification based on USGBC's LEED v4 BD+C.
1. Specific requirements for LEED are also included in other Sections.
 2. Some LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
 3. A copy of the LEED Project checklist (credit scorecard) is attached at the end of this Section for information only.
 - a. Some LEED prerequisites and credits needed to obtain the indicated LEED certification depend on aspects of Project that are not part of the Work of the Contract.
 4. Definitions included in the "LEED Version 4.0 for Building Design and Construction" (LEED v4.0 BD+C) Reference Guide and online amendments apply to this Section.
- B. Note: The pursuit of LEED certification and its procedures and requirements identified in this Section apply to building B1500 new construction only, including submittals. Sustainable design requirements indicated in the individual Sections apply to all new construction and alterations, though submittals are not required for building B1800.
- C. Related Requirements:
1. Section 013233, "Photographic Documentation."
 2. Section 013300, "Submittal Procedures."
 3. Section 017419, "Construction Waste Management and Disposal."
 4. Section 017823, "Operation and Maintenance Data."
 5. Section 018113.71 "CALGreen Non-Residential Mandatory Measures."
 6. Divisions 02 through 33 Sections for Sustainable Design requirements specific to the work of each of these Sections. Requirements may or may not include reference to LEED.
- D. In an effort to keep LEED sustainability requirements consistent for entire Project, rather than by individual Increment, review and address issues as applicable to each Increment. Project closeout shall accumulate all data and submittals required to achieve certification.
- E. Coordinate requirements of this Section with requirements for CALGreen environmental requirements indicated in Section 018113.71. Notify Architect of any discrepancies or conflicts.

1.2 DEFINITIONS

- A. **Bio-Based Materials:** Materials that meet the Sustainable Agriculture Network's Sustainable Agriculture Standard. Bio-based raw materials shall be tested using ASTM D 6866 and be legally harvested, as defined by the exporting and receiving country.
- B. **CDPH Standard Method v1.1:** California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, v. 1.1-2010, for the emissions testing and requirements of products and materials.
- C. **Chain-of-Custody (COC):** A procedure that tracks a product from the point of harvest or extraction to its end use, including all successive stage of processing, transformation, manufacturing, a distribution.

- D. Chain-of-Custody Certificates: Certificates signed by manufacturers and fabricators certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001.
- E. Composite Wood and Agrifiber: Products made of wood particles and/or plant material pressed and bonded with adhesive or resin such as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates, and door cores.
- F. Corporate Sustainability Report: A third-party verified report that outlines the environmental impacts of extraction operations and activities associated with the manufacturer's product and the product's supply chain.
- G. Environmental Product Declaration (EPD): An independently verified report based on life-cycle assessment studies that have been conducted according to a set of common rules for each product category and peer-reviewed.
 - 1. Product-Specific Declaration: A product with a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that has at least a cradle to gate scope.
 - 2. Industry-Wide (Generic) EPD: Provide products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator. EPD must conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
 - 3. Product-Specific Type III EPD: A product with a third-party certification, including external verification, in which the manufacturer is explicated recognized by the program operator. EPD must conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
- H. Extended Producer Responsibility (EPR): Measures undertaken by the maker of a product to accept its own and sometimes other manufacturers' products as postconsumer waste at the end of the products' useful life.
- I. Health Product Declaration Open Standard (HPD): A standard format for reporting product content and associated health information for building products and materials.
- J. Indoor Air Quality (IAQ) Management Plan: Plan developed by the Contractor to provide a healthy indoor environment for workers and building occupants during construction. Plan must meet or exceed the recommendations of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) "IAQ Guidelines for Occupied Buildings Under Construction, 2nd edition, 2007, ANSI/SMACNA 008-2008, Chapter 3."
- K. Leadership Extraction Practices: Products that meet at least one of the responsible extraction criteria, which include: extended producer responsibility; bio-based materials; FSC wood products; materials reuse; recycled content; and other USGBC approved programs.
- L. Material Cost: The dollar value of materials being provided to the site, after Contractor mark-ups, including transportation costs, taxes, fees, and shop labor, but excluding field equipment and field labor costs.
- M. Materials Reuse: Reuse includes salvaged, refurbished, or reused products.
- N. Multi-Attribute Optimization: Third party certified products that demonstrate impact reduction below industry average in at least three of the following six categories: global warming potential; stratospheric ozone depletion; acidification; eutrophication; tropospheric ozone creation; nonrenewable resource depletion.
- O. Recycled Content: Recycled content is the sum of postconsumer recycled content plus one-half the preconsumer recycled content, based on cost.

1. "Postconsumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
 2. "Preconsumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials, such as rework, regrind, or scrap, generated in a process and capable of being reclaimed within the same process that generated it.
- P. Regional Materials: Materials that are extracted, harvested, recovered, and manufactured within a radius of 100 miles from the Project site.
- Q. Volatile Organic Compounds (VOC) Emissions Test: Refer to CDPH Standard Method v1.1 definition.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Work of this project includes completed building and application for LEED certification. Work is not complete until District has accepted USGBC's final review of LEED certification.
1. Provide documentation required by LEED and LEED review.
- B. Provide materials and procedures necessary to obtain LEED prerequisites and credits required in this Section. Other Sections may specify requirements that contribute to LEED prerequisites and credits. Refer to other sections for additional materials and procedures necessary to obtain LEED prerequisites and credits.
- C. Respond to questions and requests for additional information from Architect and the USGBC regarding LEED credits until the USGBC has made its determination on the project's LEED certification application.
- D. LEED Online Submittals: Upload LEED documentation submittal data directly to USGBC project "LEED Online" website. Complete online forms at least monthly and as necessary to document LEED credits for submittals required in this Section.
- E. LEED Conference: Schedule and conduct a conference at a time convenient to District and Architect within 30 days prior to commencement of the work. Advise Architect, District's Commissioning Authority of scheduled meeting dates.
1. Attendees: Authorized representatives of District, District's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: LEED goals for the project, Contractor's action plans, and discussion of targeted LEED Prerequisites and Credits.
 3. Minutes: Record and distribute minutes to attendees and other entities with responsibilities for obtaining LEED Credits.

1.4 ACTION SUBMITTALS

- A. General: Submit additional LEED submittals required by other Specification Sections.
1. Submit each LEED submittal simultaneously with applicable product submittal.
- B. LEED Documentation Submittals:
1. General, LEED v4/v4.1 Product Sustainable Attribute Form: Project submittals must be accompanied by a completed LEED v4/v4.1 Product Sustainable Attribute Form. Submittal packages must also include highlighted documentation supporting the sustainability claims made on the LEED v4/v4.1 Product Sustainable Attribute Form.
 - a. Provide location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material.

2. EAp3, Building-Level Energy Metering: Product data for meters, sensors, and data collection system used to provide continuous metering of building energy-consumption performance.
3. MRp2/MRc5, Construction and Demolition Waste Management: Comply with submittal requirements of Section 017419 "Construction Waste Management and Disposal."
4. MRc2, Building Product Disclosure and Optimization: Environmental Product Declarations complying with LEED requirements.
5. MRc3, Building Product Disclosure and Optimization, Sourcing of Raw Materials: *Option 1*, Raw Material Source and Extraction Reporting.
 - a. Corporate sustainability reports for products that comply with LEED requirements for raw material and source extraction reporting.
6. MRc3, Building Product Disclosure and Optimization, Sourcing of Raw Materials: *Option 2*, Leadership Extraction Practices.
 - a. Extended Producer Responsibility: Product data and certification letter from product manufacturers, indicating participation in an extended producer responsibility program and statement of costs.
 - b. Bio-Based Materials: Product data and certification for bio-based materials, indicating that they comply with requirements. Include statement of costs.
 - c. Certified Wood: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
 - d. Materials Reuse: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs.
 - e. Recycled Content: Product data and certification letter from product manufacturers, indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement of costs.
7. MRc4, Building Product Disclosure and Optimization, Material Ingredients: *Option 1*, Material Ingredient Reporting.
 - a. Material ingredient reports for products that comply with LEED requirements for material ingredient reporting, including but not limited to the following:
 - 1) Manufacturer Inventory.
 - 2) Health Product Declaration.
 - 3) Cradle to Cradle certifications.
 - 4) Declare product labels.
 - 5) ANSI/BIFMA e3 Furniture Sustainability Standard.
8. MRc4, Building Product Disclosure and Optimization, Material Ingredients: *Option 2*, Material Ingredient Optimization.
 - a. Documentation for products that comply with LEED requirements for material ingredient optimization, including but not limited to the following:
 - 1) GreenScreen Benchmarks.
 - 2) Cradle to Cradle certifications.
 - 3) REACH optimizations.
9. EQc3, Construction Indoor Air Quality Management:
 - a. Construction indoor-air-quality (IAQ) management plan. (See Paragraph 3.3.A)
 - b. Product data for temporary filtration media.
 - c. Product data for filtration media used during occupancy.
 - d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.
10. EQc2, Low-Emitting Materials: Product data, indicating VOC content and emissions testing documents showing compliance with requirements for low-emitting materials, for the following materials:
 - a. Paints and coatings.
 - b. Adhesives and sealants.

- c. Flooring.
- d. Products containing composite wood or agrifiber products or wood glues.
- e. Ceilings, walls, thermal, and acoustic insulation.
- f. Exterior applied materials.
- g. Furniture.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For LEED coordinator.
- B. Project Materials Cost Data: Provide statement indicating total cost and shop labor for materials used for Project. Costs exclude site labor, overhead, and profit. Include breakout of costs for the following categories of items:
 1. Wood construction materials.
 2. Furniture.
 3. Passive plumbing materials.
 4. Passive mechanical (HVAC) materials.
 5. Passive electrical materials.
 6. Earthwork and exterior improvements, hard costs.
- C. LEED Building Disclosure and Optimization (BPDO) Credit Action Plans: Provide preliminary submittals within 30 days of date established for the Notice to Proceed indicating how the following requirements will be met:
 1. General
 - a. The LEED-NC v4.1 credits can be used as the basis for all BPDO credits.
 - b. Use the LEED-NC v4.1 BPDO calculator to complete all BPDO Action Plans. A copy of the calculator is available at: <https://www.usgbc.org/resources/leed-v41-bpdo-calculator>.
 - c. These electronic forms shall be provided by the Architect at the beginning of the Construction Phase and reviewed in the Preconstruction Conference.
 2. MRc2 - Building Disclosure and Optimization - EPD; Option 1. List at least 20 different permanently installed products sourced from at least five different manufacturers that the Contractor intends to procure that meet the Life-Cycle Assessment or Environmental Product Declarations complying with the requirements listed in LEED v4.1 for Credit MRc2 Option 1
 3. MRc2 - Building Disclosure and Optimization - EPD; Option 2. List the products that the Contractor intends to procure representing at least 10% of the cost of the total value of permanently installed products in the project, or at least 5 permanently installed products sourced from at least three different manufacturers that meet the Life-Cycle Impact Reduction Action Plan requirements or the Life Cycle Impact Reductions in Embodied Carbon requirements listed in LEED v4.1 for Credit MRc2 Option 2.
 4. MRc3 - Building Disclosure and Optimization - Sourcing of Raw Materials; *Option 1*. List the products that the Contractor intends to procure representing at least 15% of the cost of the total value of permanently installed products in the project, sourced from at least three different manufacturers that meet at least one of the responsible sourcing and extraction criteria listed in LEED v4.1 for Credit MRc3.
 5. MRc3 - Building Disclosure and Optimization - Sourcing of Raw Materials; *Option 2*. List the products that the Contractor intends to procure representing at least 30% of the cost of the total value of permanently installed products in the project, sourced from at least five different manufacturers that meet at least one of the responsible sourcing and extraction criteria listed in LEED v4.1 for Credit MRc3.
 6. MRc4 - Building Disclosure and Optimization - Materials Ingredients; Option 1. List at least 20 different permanently installed products sourced from at least five different manufacturers that the Contractor intends to procure that use any of the programs listed in LEED v4.1 for Credit MRc4 Option 1 to demonstrate the chemical inventory of the product to at least 0.1% (1000 ppm)

7. MRc4 - Building Disclosure and Optimization - Materials Ingredients; Option 2. List the products that the Contractor intends to procure representing at least 10% of the cost of the total value of permanently installed products in the project, or at least 5 permanently installed products sourced from at least three different manufacturers for which the manufacturer documents material ingredient optimization using the paths listed in LEED v4.1 for Credit MRc4 Option 2.
- D. LEED Credit Action Plan: Provide preliminary submittals within 7 days of date established for the Notice to Proceed indicating how the following requirements will be met:
 1. MRp2/MRc5, Waste management plan, complying with Section 017419 "Construction Waste Management and Disposal."
 2. EQc3 - Construction IAQ Management Plan:
 - a. Document all control measures to be used during construction to comply with the SMACNA IAQ Guidelines for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008-2008, Chapter 3.
 - b. Describe proposed measures to protect absorptive materials stored on-site and installed from moisture damage.
 - c. Describe methods to prohibit the use of tobacco products inside the building and within 25 feet (8 meters) of the building entrance during construction.
- E. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:
- F. MRp2/MRc5, Waste reduction progress reports complying with Section 017419 "Construction Waste Management and Disposal."
- G. MRc2, Building product disclosure and optimization - environmental product declarations.
- H. MRc3, Building product disclosure and optimization - sourcing of raw materials.
- I. MRc4, Building product disclosure and optimization - material ingredients.
- J. EQc2, Low emitting materials.
 1. Low Emitting Materials Tracking Sheet monitoring the project's progress towards targeted LEED Indoor Environmental Quality Credits. Tracking Sheet to be presented at construction meetings.

1.6 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.
- B. LEED Preconstruction Meeting: Architect to conduct meeting at project site as part of the Pre-Construction Conference to comply with requirements of this section.
 1. The General Contractor shall require all major subcontractors to attend meeting.
 2. Review methods and procedures related to managing the LEED construction process and to include, but are not limited to the following:
 - a. Understanding LEED process and terminology.
 - b. Understanding contractor responsibilities and LEED submittal process.
 - c. Maintaining proper meeting minutes, records, and tracking mechanisms related to LEED credit responsibilities.
 - d. Understanding LEED certification process and filling out LEED Online submittal forms.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated. Contractor to determine a combination of credit options best suited for achieving credits required.
1. Exclusions: Special equipment, such as elevators, escalators, process equipment, and fire suppression systems, is excluded from the credit calculations. Also excluded are products purchased for temporary use on the project, like formwork for concrete.

2.2 BUILDING PRODUCT DISCLOSURE AND OPTIMIZATION

- A. MRc2, Building Product Disclosure and Optimization, Environmental Product Declarations (EPD): *Option 1*.
1. Provide at least 20 permanently installed products (sourced from at least 5 different manufacturers) which meet one of the disclosure criteria:
 - a. Product-Specific Declaration: Valued as one quarter (1/4) of a product.
 - b. Industry-Wide (Generic) EPD: Valued as one half (1/2) of a product.
 - c. Product-Specific Type III EPD: Valued as one whole product.
 2. Products sourced within 100 miles of the project site are valued at twice their contributing cost or number of products.
 3. The following 20 products have been selected to comply with MRc2, *Option 1*. If the Contractor chooses not include any of these products in the Project, the Contractor shall propose an alternative product that complies with the credit requirements in its place:
 - a. To be selected by LEED coordinators.
- B. MRc2, Building Product Disclosure and Optimization, Environmental Product Declarations (EPD): *Option 2*.
1. Provide products representing at least 10% of the cost of the total value of permanently installed products in the project, or at least 5 permanently installed products sourced from at least three different manufacturers that meet one of the disclosure criteria:
 - a. Life Cycle Impact Reduction Action Plan
 - b. Life Cycle Impact Reductions in Embodied Carbon
 - c. Products with environmental impact reductions demonstrated by third-party verified EPDs conforming to ISO 14025 and ISO 21930
 2. Products sourced within 100 miles of the project site are valued at twice their contributing cost or number of products.
 3. The following 5 products have been selected to comply with MRc2, *Option 2*. If the Contractor chooses not include any of these products in the Project, the Contractor shall propose an alternative product that complies with the credit requirements in its place:
 - a. To be selected by LEED coordinators.
- C. MRc3, Building Product Disclosure and Optimization, Sourcing of Raw Materials: *Option 1*, Responsible Sourcing of Raw Materials. Use products sourced from at least three different manufacturers that meet at least one of the responsible sourcing and extraction criteria below for at least 15%, by cost, of the total value of permanently installed building products in the project:
1. Extended producer responsibility program.
 2. Bio-based materials.
 3. Certified Wood: Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
 - a. Rough carpentry.

- b. Miscellaneous carpentry.
 - c. Heavy timber construction.
 - d. Wood decking.
 - e. Metal-plate-connected wood trusses.
 - f. Structural glued-laminated timber.
 - g. Finish carpentry.
 - h. Architectural woodwork.
 - i. Wood paneling.
 - j. Wood veneer wall covering.
 - k. Wood flooring.
 - l. Wood lockers.
 - m. Wood cabinets.
 - n. Furniture.
4. Recycled content.
- a. Exceptions: Do not include furniture, fire protection, operational plumbing, operational mechanical, and operational electrical components, and specialty items, such as elevators and equipment, in the calculation.
5. Products sourced within 100 miles of the project site are valued at twice their contributing cost.
- D. MRc3, Building Product Disclosure and Optimization, Sourcing of Raw Materials: *Option 2*, Responsible Sourcing of Raw Materials. Use products sourced from at least three different manufacturers that meet at least one of the responsible sourcing and extraction criteria listed in 2.2 C. above for at least 30%, by cost, of the total value of permanently installed building products in the project.
- E. MRc4, Building Product Disclosure and Optimization, Material Ingredients: *Option 1*, Material Ingredient Reporting.
- 1. Use at least 20 different permanently installed products from at least five different manufacturers that use any of the following programs to demonstrate the chemical inventory of the product to at least 0.1% (1000 ppm), which meet one of the following disclosure criteria:
 - a. Manufacturer Inventory.
 - b. Health Product Declarations (HPDs).
 - c. Cradle to Cradle (C2C) certifications.
 - d. Declare product labels.
 - e. Living Building Challenge
 - f. ANSI/BIFMA e3 Furniture Sustainability Standard.
 - g. Product Lens Certification
 - h. Facts - NSF/ANSI 336: Sustainability Assessment for Commercial Furnishings Fabric
 - 2. Products sourced within 100 miles of the project site are valued at twice their contributing cost or number of products.
 - 3. The following 20 products have been selected to comply with MRc4, *Option 1*. If the Contractor chooses not include any of these products in the Project, the Contractor shall propose an alternative product that complies with the credit requirements in its place:
 - a. To be selected by LEED coordinators.
- F. MRc4, Building Product Disclosure and Optimization, Material Ingredients: *Option 2*, Material Ingredient Optimization.
- 1. Use products representing at least 10% of the cost of the total value of permanently installed products in the project, or at least 10 permanently installed products sourced from at least three different manufacturers that document their material ingredient optimization using the paths below, which meet one of the following disclosure criteria:
 - a. Material Ingredient Screening and Optimization Action Plan
 - b. Advanced Inventory & Assessment
 - c. Material Ingredient Optimization
 - d. GreenScreen benchmarks.
 - e. Declare Labels designated as Red List Free

- f. Cradle to Cradle version 3 or later certifications.
 - g. REACH optimizations.
2. Products sourced within 100 miles of the project site are valued at twice their contributing cost or number of products.
 3. The following 10 products have been selected to comply with MRc4, *Option 2*. If the Contractor chooses not include any of these products in the Project, the Contractor shall propose an alternative product that complies with the credit requirements in its place:
 - a. To be selected by LEED coordinators.

2.3 LOW-EMITTING MATERIALS

- A. EQc2, Low-Emitting Materials, *General Emissions Requirements*: Products must demonstrate they have been tested and determined compliant in accordance with California Department of Public Health, (CDHP), Standard Method v1.1-2010, using the applicable exposure scenario. Manufacturer's documentation demonstrating compliance must state the range of total VOCs (tVOC) after 14 days measured as specified in the CDPH Standard Method v1.1 as follows:
1. 0.5mg/m3 or less,
 2. between 0.5 and 5.0 mg/m3 or,
 3. 0.50 mg/m3 or more.
- B. EQc2, Low-Emitting Materials, *Paints and Coatings*: For field applications that are inside the weatherproofing system, use paints and coatings that comply with the limits for VOC content when calculated according to the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113, effective June 3, 2011.

Product Type:	Allowable VOC Content (g/L):
Bond Breaker	350
Clear wood finishes - Varnish	275
Clear wood finishes - Sanding Sealer	275
Clear wood finishes - Lacquer	275
Colorant - Architectural Coatings, excluding IM coatings	50
Colorant - Solvent Based IM	600
Colorant - Waterborne IM	50
Concrete - Curing compounds	100
Concrete - Curing compounds for roadways & bridges	350
Concrete surface retarder	50
Driveway Sealer	50
Dry-fog coatings	50
Faux finishing coatings - Clear topcoat	100
Faux finishing coatings - Decorative Coatings	350
Faux finishing coatings - Glazes	350
Faux finishing coatings - Japan	350
Faux finishing coatings - Trowel applied coatings	50
Fire-proof coatings	150
Flats	50
Floor coatings	50
Form release compounds	100
Graphic arts (sign) coatings	150
Industrial maintenance coatings	100
Industrial maintenance coatings - High temperature IM coatings	420
Industrial maintenance coatings - Non-sacrificial anti-graffiti coatings	100

Industrial maintenance coatings - Zinc rich IM primers	100
Magnesite cement coatings	450
Mastic coatings	100
Metallic pigmented coatings	150
Multi-color coatings	250
Non-flat coatings	50
Pre-treatment wash primers	420
Primers, sealers and undercoaters	100
Reactive penetrating sealers	350
Recycled coatings	250
Roof coatings	50
Roof coatings, aluminum	100
Roof primers, bituminous	350
Rust preventative coatings	100
Stone consolidant	450
Sacrificial anti-graffiti coatings	50
Shellac- Clear	730
Shellac - Pigmented	550
Specialty primers	100
Stains	100
Stains, interior	250
Swimming pool coatings - repair	340
Swimming pool coatings - other	340
Traffic Coatings	100
Waterproofing sealers	100
Waterproofing concrete/masonry sealers	100
Wood preservatives	350
Low solids coatings	120

C. EQc2, Low-Emitting Materials, *Paints and Coatings*: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. EQc2, Low-Emitting Materials, *Adhesives and Sealants*: For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the limits for VOC content when calculated according to South Coast Air Quality Management District (SCAQMD) Rule #1168, requirements in effect on July 1, 2005, and rule amendment date January 7, 2005:

Architectural Applications:	Allowable VOC Content (g/L):
Indoor carpet adhesives	50
Carpet pad adhesives	50
Outdoor carpet adhesives	150
Wood flooring adhesives	100
Rubber floor adhesives	60
Subfloor adhesives	50
Ceramic tile adhesives	65
VCT and asphalt tile adhesives	50
Dry wall and panel adhesives	50
Cove base adhesives	50
Multipurpose construction adhesives	70
Structural glazing adhesives	100
Single ply roof membrane adhesives	250
Specialty Applications:	

PVC welding	510
CPVC welding	490
ABS welding	325
Plastic cement welding	250
Adhesive primer for plastic	550
Computer diskette manufacturing	350
Contact adhesive	80
Special purpose contact adhesive	250
Tire retread	100
Adhesive primer for traffic marking tape	150
Structural wood member adhesive	140
Sheet applied rubber lining operations specialty	850
Top and Trim adhesive	250
Substrate Specific Applications:	
Metal to metal substrate specific adhesives	30
Plastic foam substrate specific adhesives	50
Porous material (except wood) substrate specific adhesives	50
Wood substrate specific adhesives	30
Fiberglass substrate specific adhesives	80
Sealants:	
Architectural sealant	250
Marine deck sealant	760
Nonmember roof sealant	300
Roadway sealant	250
Single-ply roof membrane sealant	450
Other sealant	420
Sealant Primers:	
Architectural non-porous sealant primer	250
Architectural porous sealant primer	775
Modified bituminous sealant primer	500
Marine deck sealant primer	760
Other sealant primer	750
Other	
Other adhesives, adhesive bonding primers, adhesive primers or any other primers	250

1. Exception: The provisions of SCAQMD Rule 1168 do not apply to adhesives and sealants subject to state or federal consumer product VOC regulations.
- E. EQc2, Low-Emitting Materials, *Adhesives and Sealants*: For field applications that are inside the weatherproofing system, 90 percent of adhesives and sealants shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. EQc2, Low-Emitting Materials, *Flooring*: Flooring shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- G. EQc2, Low-Emitting Materials, *Composite Wood*: Composite wood, agrifiber products, and adhesives shall be made using ultra-low-emitting formaldehyde (ULEF) resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde. Alternately, EN 717-1:2014 is acceptable as well.

- H. EQc2, Low-Emitting Materials, *Ceilings, Walls, Thermal, and Acoustic Insulation*: Ceilings, walls, and thermal insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- I. EQc2, Low-Emitting Materials, *Exterior Applied Materials*: At least 90 percent of exterior applied materials, measured by volume, shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 1. The following materials are prohibited and do not count toward total percentage compliance:
 - a. Hot-mopped asphalt for roofing.
 - b. Coal tar sealants for parking lots and other paved surfaces.
- J. EQc2, Low-Emitting Materials, *Furniture*: At least 90 percent of furniture, measured by cost, shall be tested in accordance with ANSI/BIFMA Standard Method M7.1-2011 (R-2016); comply with ANSI/BIFMA e3-2014 Furniture Sustainability Standard, Sections 7.6.1 (half credit) and/or 7.6.2 (full credit), using either the concentration modeling approach or the emissions factor approach; and model the test results using the open plan, private office, or seating scenario in ANSI/BIFMA M7.1, as appropriate.
- K. Additional Low-Emitting Requirements:
 - 1. If the applicable regulation requires subtraction of exempt compounds, any content of intentionally added exempt compounds larger than 1% weight by mass (total exempt compounds) must be disclosed.
 - 2. If a product cannot reasonably be tested as specified above, testing of VOC content must comply with ASTM D2369-10; ISO 11890, part 1; ASTM D6886-03; or ISO 11890-2.
 - 3. Methylene chloride and perchloroethylene may not be intentionally added in paints, coatings, adhesives, or sealants.

2.4 INDOOR WATER USE REDUCTION

- A. WEp2, Indoor Water Use Reduction, Appliances: Provide ENERGY STAR or performance equivalent appliances.
- B. WEp2/WEc2, Indoor Water Use Reduction, Plumbing Fixtures: Do not exceed water flow requirements indicated in Division 22 - PLUMBING.

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

- A. EQp2, Environmental Tobacco Smoke Control: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.

3.2 CONSTRUCTION WASTE MANAGEMENT

- A. MRp2/MRc5, Construction and Demolition Waste Management: Comply with Section 017419 "Construction Waste Management and Disposal."

3.3 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

- A. EQc3, Construction Indoor Air Quality Management Plan:
 - 1. Meet or exceed all applicable recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008-2008, Chapter 3.

- a. If District authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section "Temporary Utilities," install filter media having a MERV 8 according to ASHRAE 52.2-2007 at each return-air inlet for the air-handling system used during construction.
 - b. Replace all air filters immediately prior to occupancy.
2. Protect absorptive materials stored on-site and installed from moisture damage.
 3. Prohibit the use of tobacco products inside the building and within 25 feet (8 meters) of the building entrance during construction
- B. EQc4 - Indoor Air Quality Assessment
- C. Flush-Out:
1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14,000 cu. ft. (4 300 000 L) of outdoor air per sq. ft. (sq. m) of floor area while maintaining an internal temperature of at least 60 deg F (16 deg C) and a relative humidity no higher than 60 percent.
 2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. (1 070 000 L) of outdoor air per sq. ft. (sq. m) of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. (1.52 L/s per sq. m) of outside air or the design minimum outside-air rate, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14,000 cu. ft./sq. ft. (4 300 000 L/sq. m) of outside air has been delivered to the space.
- D. Air-Quality Testing: District will engage testing agency to perform the following:
1. Conduct baseline IAQ testing, after construction ends and prior to occupancy, using testing protocols listed in Section 018113.71 "CALGreen Non-Residential Mandatory Measures" and as additionally detailed in the USGBC's "LEED Reference Guide for Building Design and Construction."
 2. Demonstrate that the contaminant maximum concentrations listed in Section 018113.71 "CALGreen Non-Residential Mandatory Measures" are not exceeded. In addition, include the following:
 - a. Target Chemicals in California Department of Public Health "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Table 4-1 (except formaldehyde): Allowable concentrations in California Department of Public Health "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Table 4-1.
 3. For each sampling point where the maximum concentration limits are exceeded, take corrective action until requirements have been met.
 4. Air-sample testing shall be conducted as follows:
 - a. All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside-air flow rate for the occupied mode throughout the duration of the air testing.
 - b. Building shall have all interior finishes installed, including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings, such as workstations and partitions, are encouraged, but not required, to be in place for the testing.
 - c. Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 5000 sq. ft. (465 sq. m).
 - d. Air samples shall be collected between 3 and 6 feet (900 and 1800 mm) from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION 018113.15



LEED v4 for BD+C: New Construction and Major Renovation Project Checklist

Project Name: Las Positas College STEAM Building
Date: 12/10/24

Y ? N	d	Credit 1	Integrative Process	1
1				
4				16
1		d	Credit 1 LEED for Neighborhood Development Location	16
1		d	Credit 2 Sensitive Land Protection	1
1		d	Credit 3 High Priority Site	2
5		d	Credit 4 Surrounding Density and Diverse Uses	5
1		d	Credit 5 Access to Quality Transit	5
1		d	Credit 6 Bicycle Facilities (LEED v4.1)	1
1		d	Credit 7 Reduced Parking Footprint	1
1		d	Credit 8 Green Vehicles	1

8	2	Sustainable Sites	10
Y			Required
1		d	Credit 1 Construction Activity Pollution Prevention
1		d	Credit 2 Site Assessment
1		d	Credit 3 Site Development - Protect or Restore Habitat (LEED V4.1)
2		d	Credit 4 Open Space (LEED V4.1)
2		d	Credit 5 Rainwater Management
2		d	Credit 6 Heat Island Reduction
1		d	Credit 7 Light Pollution Reduction

7	4	Water Efficiency	11
Y			Required
Y		d	Prereq 1 Outdoor Water Use Reduction
Y		d	Prereq 2 Indoor Water Use Reduction
2		d	Prereq 3 Building-Level Water Metering
4		d	Credit 1 Outdoor Water Use Reduction
2		d	Credit 2 Indoor Water Use Reduction
2		d	Credit 3 Cooling Tower Water Use
1		d	Credit 4 Water Metering

9	6	20	Energy and Atmosphere	33
Y				Required
Y			d	Prereq 1 Fundamental Commissioning and Verification
Y			d	Prereq 2 Minimum Energy Performance
Y			d	Prereq 3 Building-Level Energy Metering
3	1	2	d	Prereq 4 Fundamental Refrigerant Management
6	2	10	c	Credit 1 Enhanced Commissioning -Client is bringin in Commissioning agent
1			d	Credit 2 Optimize Energy Performance
1			d	Credit 3 Advanced Energy Metering
1			d	Credit 4 Demand Response
5			d	Credit 5 Renewable Energy Production (LEED V4.1)
1			d	Credit 6 Enhanced Refrigerant Management
2			c	Credit 7 Green Power and Carbon Offsets (LEED v4.1 change)

6	2	5	Materials and Resources	13
Y				Required
Y			d	Prereq 1 Storage and Collection of Recyclables
1		4	c	Prereq 2 Construction and Demolition Waste Management Planning
1		1	d	Credit 1 Building Life-Cycle Impact Reduction
2			c	Credit 2 Building Product Disclosure and Optimization - Environmental Product Declarations (LEED V4.1)
2			c	Credit 3 Building Product Disclosure and Optimization - Sourcing of Raw Materials
2			c	Credit 4 Building Product Disclosure and Optimization - Material Ingredients (LEED V4.1)
1		1	c	Credit 5 Construction and Demolition Waste Management

9	6	1	Indoor Environmental Quality	16
Y				Required
Y			d	Prereq 1 Minimum Indoor Air Quality Performance
2			d	Prereq 2 Environmental Tobacco Smoke Control
3			d	Credit 1 Enhanced Indoor Air Quality Strategies
1			c	Credit 2 Low-Emitting Materials (LEED v4.1)
1			c	Credit 3 Construction Indoor Air Quality Management Plan
1		1	c	Credit 4 Indoor Air Quality Assessment
1		1	d	Credit 5 Thermal Comfort
1		1	d	Credit 6 Interior Lighting
2			d	Credit 7 Daylight
1			d	Credit 8 Quality Views
1			d	Credit 9 Acoustic Performance

5	Innovation	6
1	d	1
1	d	1
1	c	1
1	d	1
1	d	1
1	d	1

3	2	1	Regional Priority	4
1			d	Credit 1.1 Regional Priority: Optimize Energy Performance (Threshold=10)
1			d	Credit 1.2 Regional Priority: Surrounding Density & Diverse Uses (Threshold=5)
1			d	Credit 1.3 Regional Priority: Access to Quality Transit (Threshold=3)
1			d	Credit 1.4 Regional Priority: Reduced Parking Footprint (Threshold=1)
1			d	Credit 1.5 Regional Priority: Rainwater Management (Threshold=2)
1			d	Credit 1.6 Regional Priority: Indoor Water Use Reduction (Threshold=4)

52	18	43	TOTALS	Possible Points: 110
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Certified: 40 to 49 points, Silver: 50 to 59 points, Gold: 60 to 79 points, Platinum: 80 to 110

SECTION 018113.71 - CALGREEN NON-RESIDENTIAL MANDATORY MEASURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements and procedures for compliance with and certification from 24 CCR 11 (hereafter, "CALGreen").
 - 1. Some CALGreen requirements depend on product selections and may not be specifically identified as CALGreen requirements. Compliance with CALGreen requirements may be used as one criterion to evaluate substitution requests and comparable product requests.
 - 2. Copies of CALGreen project checklists can be obtained from the CALGreen website. (www.dgs.ca.gov/BSC/CALGreen). The checklists are for Mandatory Measures, with additional available for the voluntary CALGreen Tier 1 and Tier 2 levels of certification.
 - a. Some CALGreen requirements depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

1.2 DEFINITIONS

- A. Environmental Product Declaration (EPD): An independently verified report based on life-cycle assessment studies that have been conducted according to a set of common rules for each product category and peer-reviewed.
 - 1. Product-Specific Type III EPD: A product with a third-party certification, including external verification, in which the manufacturer is explicitly recognized by the program operator. EPD shall conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930, and shall have at least a cradle to gate scope.
- B. Composite Wood Products: Hardwood plywood, particleboard, and medium-density fiberboard. Composite wood products do not include hardboard, structural plywood.
- C. Global Warming Potential (GWP): The radioactive forcing impact of one mass-based unit of a given greenhouse gas relative to an equivalent unit of carbon dioxide over a given period of time. Carbon dioxide is the reference compound with a GWP of one.
- D. Global Warming Potential Value (GWP Value): The 100-year GWP value published by the Inter-governmental Panel on Climate Change (IPCC) in either its Second Assessment Report (SAR) (IPCC, 1995); or its Fourth Assessment A-3 Report (AR4) (IPCC, 2007). The SAR GWP values are found in column "SAR (100-yr)" of Table 2.14; the AR4 GWP values are found in column "100 yr" of Table 2.14.
- E. Recycled Content: Component of a material made of recycled materials. Recycled material can be derived from two sources: pre-consumer, also known as "post-industrial," or "post-consumer." "Post-consumer recycled material" refers to items, such as aluminum cans, that have been in the consumer market. Post-industrial material is waste generated from the original manufacturing process that is used again.
- F. VOCs: Volatile organic compounds.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project Site. Review CALGreen requirements and action plans for compliance with requirements. Also, reference Section 013119 "Project Meetings" for further information.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Respond to questions and requests from Architect about CALGreen requirements that depend on product selection or product qualities. Document responses as informational submittals.
- B. Submit documentation to enforcing agency for credits that are the responsibility of Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until enforcing agency has made its determination on Project's CALGreen certification application.
 - 1. Document correspondence with review team, as assigned by the enforcing agency, as informational submittals.
- C. Environmental Management System: Document the following:
 - 1. Environmental policy.
 - 2. Regulatory compliance and training.
 - 3. Environmental risk assessment that shows sensitive environmental areas and ranks potential risks that may arise from the construction.
 - 4. Environmental risk management strategies.
 - 5. Environmental management roles, responsibilities, and reporting structure for the construction phase.
 - 6. Site and work instructions for site personnel, outlining environmental procedures during construction.
 - 7. Environmental inspection checklists.
 - 8. Records of compliance.

1.5 ACTION SUBMITTALS

- A. General: Submit additional sustainable design submittals required by other Specification Sections.
- B. Sustainable design submittals are in addition to other submittals.
 - 1. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record copy of compliance with indicated CALGreen requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable Design Submittal."
- C. Sustainable Design Documentation Submittals:
 - 1. Stormwater pollution prevention plan.
 - 2. Product data for irrigation system components, including, but not limited to, the following:
 - a. Sprinkler Heads: Indicate degree of head rotation and spray characteristics/pattern.
 - b. Controllers and sensors.
 - 3. Product data and schedules for plumbing fixtures and fittings. Include rated capacities and WaterSense certification where applicable.
 - 4. Product data for residential appliances, indicating that products are Energy Star rated.
 - 5. Environmental management system documents.
 - 6. Lighting controls.
 - 7. Environmental product declarations.
 - 8. Third-party certifications based on multiple-attribute standards.
 - 9. Third-party-certified life-cycle product assessments.
 - 10. Product data, manufacturer's certifications, chain-of-custody certification, or other documentation acceptable to authorities having jurisdiction; for products containing composite wood, agrifiber products, or wood glues, indicate compliance with California Air Resource Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Missions from Composite Wood."
 - 11. Construction waste and recycling plan complying with Section 017419 "Construction Waste Management."

12. Product data and laboratory test reports for adhesives and sealants indicating VOC content and compliance with requirements for low-emitting materials.
13. Certificates for carpet and undercarpet adhesives indicating compliance with Carpet and Rug Institute's Green Label Plus testing program.
14. Product data and laboratory test reports for paints and coatings indicating VOC content and compliance with requirements for low-emitting materials.
15. Laboratory test reports for hard flooring, insulation, acoustical ceilings, and wall coverings, indicating compliance with requirements for low-emitting materials, as defined in "Low-Emitting Materials" Article.
16. IAQ testing report from testing and inspecting agency indicating results of IAQ testing and documentation that show compliance with IAQ testing procedures and requirements.
17. Type III Environmental Product Declarations for products required to comply, including: Ready-mixed concrete, hot rolled steel sections, hollow structural sections, steel plate, concrete reinforcing steel, flat glass, and mineral wool board insulation.

1.6 INFORMATIONAL SUBMITTALS

- A. Project Materials Cost Data: Submit statement indicating total cost for materials used for the Work. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
 1. Plumbing.
 2. Mechanical.
 3. Electrical.
 4. Specialty items, such as elevators and equipment.
 5. Wood-based construction materials.
- B. Sustainable Design Action Plans: Submit preliminary submittals within 30 days of date established for the Notice of Award indicating how the following requirements will be met:
 1. CALGreen checklist for mandatory measures.
 2. CALGreen Tier 1 or Tier 2 checklist as required.
 3. List of products with environmental product declarations.
 4. List of products complying with requirements for multiple-attribute standards.
 5. List of products complying with requirements for life-cycle product assessments.
 6. Environmental policy.
 7. Construction Waste and Recycling Plan complying with Section 017419 "Construction Waste Management."
 8. Construction IAQ management plan.
- C. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide products and procedures necessary to comply with CALGreen requirements referenced in the Evaluations. Although other Sections may specify some requirements that contribute to referenced CALGreen requirements, determine additional materials and procedures necessary to comply with CALGreen requirements indicated.

2.2 LOW-EMITTING MATERIALS

- A. Adhesives and Sealants:
 1. For field applications inside the building, adhesives and sealants shall comply with the following VOC content limits:
 - a. Wood Glues: 30 g/L.

- b. Metal-to-Metal Adhesives: 30 g/L.
 - c. Adhesives for Porous Materials (except Wood): 50 g/L.
 - d. Subfloor Adhesives: 50 g/L.
 - e. Plastic Foam Adhesives: 50 g/L.
 - f. Carpet Adhesives: 50 g/L.
 - g. Carpet Pad Adhesives: 50 g/L.
 - h. VCT and Asphalt Tile Adhesives: 50 g/L.
 - i. Cove Base Adhesives: 50 g/L.
 - j. Gypsum Board and Panel Adhesives: 50 g/L.
 - k. Rubber Floor Adhesives: 60 g/L.
 - l. Ceramic Tile Adhesives: 65 g/L.
 - m. Multipurpose Construction Adhesives: 70 g/L.
 - n. Fiberglass Adhesives: 80 g/L.
 - o. Contact Adhesive: 80 g/L.
 - p. Structural Glazing Adhesives: 100 g/L.
 - q. Wood Flooring Adhesive: 100 g/L.
 - r. Single-Ply Roof Membrane Adhesive: 250 g/L.
 - s. Special-Purpose Contact Adhesive (Contact Adhesive That Is Used to Bond Melamine Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
 - t. Plastic Cement Welding Compounds: 250 g/L.
 - u. ABS Welding Compounds: 325 g/L.
 - v. CPVC Welding Compounds: 490 g/L.
 - w. PVC Welding Compounds: 510 g/L.
 - x. Adhesive Primer for Plastic: 550 g/L.
 - y. Architectural Sealants: 250 g/L.
 - z. Nonmembrane Roof Sealants: 300 g/L.
 - aa. Single-Ply Roof Membrane Sealants: 450 g/L.
 - bb. Other Sealants: 420 g/L.
2. For field applications inside the building, adhesives and sealants must comply with the requirements of SCAQMD Rule 1168 or local code when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Carpet, cushion, and undercarpet adhesives will comply with CRI's Green Label Plus testing program.
- C. Paints: For field applications inside the building, wall paints must comply with local code requirements when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Resilient Flooring: Flooring must be certified by the Resilient Floor Covering Institute and/or be compliant when tested in accordance with the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Flooring must also comply with the Collaborative for High Performance Schools (CHPS) requirements.
- E. Thermal Insulation: Provide insulation complying with CALGreen Tier 1 or 2 requirements.
- F. Ceiling and Wall Panels: Acoustical ceiling and wall-cladding products must comply with the VOC emissions limits defined in the CHPS criteria and be listed in the CHPS Pre-Approved Products database or have a Greenguard Certification Program.

2.3 LOW-CARBON MATERIALS

- A. The following products shall achieve a GWP below the maximum acceptable value indicated according to CALGreen Table 5.409.3 - Product GWP Limits.

PART 3 - BUY CLEAN CALIFORNIA MATERIALS PRODUCT CATEGORY	PART 4 - MAXIMUM ACCEPTABLE GWP VALUE (Unfabricated)	PART 6 - UNIT OF MEASUREMENT
	PART 5 - (GWP allowed)	
PART 7 - Hot-rolled structural steel sections	PART 8 - 1.77	PART 9 - MT CO2e/MT
PART 10 - Hollow structural sections	PART 11 - 3.00	PART 12 - MT CO2e/MT
PART 13 - Steel plate	PART 14 - 2.61	PART 15 - MT CO2e/MT
PART 16 - Concrete reinforcing steel	PART 17 - 1.56	PART 18 - MT CO2e/MT
PART 19 - Flat Glass	PART 20 - 2.50	PART 21 - MT CO2e/MT
PART 22 - Light-density mineral wool board insulation	PART 23 - 5.83	PART 24 - MT CO2e/MT
PART 25 - Heavy-density mineral wool board insulation	PART 26 - 14.28	PART 27 - MT CO2e/MT
PART 28 - CONCRETE PRODUCT CATEGORY	PART 30 - MAXIMUM GWP ALLOWED VALUE (GWP allowed)	PART 31 - UNIT OF MEASUREMENT
PART 29 - (Concrete, Ready-Mixed)		
PART 32 - up to 2499 psi	PART 33 - 450	PART 34 - kg CO2/m3
PART 35 - 2500-3499 psi	PART 36 - 489	PART 37 - kg CO2/m3
PART 38 - 3500-4499 psi	PART 39 - 566	PART 40 - kg CO2/m3

PART 41 - 4500-5499 psi	PART 42 - 661	PART 43 - kg CO2/m3
PART 44 - 5500-6499 psi	PART 45 - 701	PART 46 - kg CO2/m3
PART 47 - 6500 psi and greater	PART 48 - 799	PART 49 - kg CO2/m3
PART 50 - CONCRETE PRDOUCT CATEGORY	PART 52 - MAXIMUM GWP ALLOWED VALUE (GWP allowed)	PART 53 - UNIT OF MEASUREMENT
PART 51 - (Lighweight Concrete, Ready-Mixed)		
PART 54 - up to 2499 psi	PART 55 - 875	PART 56 - kg CO2/m3
PART 57 - 2500-3499 psi	PART 58 - 956	PART 59 - kg CO2/m3
PART 60 - 3500-4499 psi	PART 61 - 1039	PART 62 - kg CO2/m3

PART 63 - EXECUTION

63.1 CONSTRUCTION WASTE MANAGEMENT

- A. CALGreen requires use of a construction waste management plan outlining how waste will be divided on the construction site, as well as how often it will be hauled to a landfill or recycling center and by whom.
- B. CALGreen includes a sample plan outlining all specific requirements of the plan.
- C. Comply with Section 017419 "Construction Waste Management."

63.2 COMMISSIONING

- A. CALGreen requires commissioning of the building mechanical and electrical systems to ensure proper installation and optimized performance as the building starts to be occupied. It also requires a systematic quality assurance process that spans the entire design and construction process and includes verifying and documenting that building systems and components are planned, designed, installed, tested, operated, and maintained to meet Owner's project requirements.

63.3 INDOOR-AIR-QUALITY ASSESSMENT

- A. Air-Quality Testing:

1. Conduct baseline IAQ testing, after substantial completion of construction and prior to occupancy, in accordance with the CALGreen *Section A5.504.2.1: IAQ testing (2022)*.
2. Verify compliance with standards and limits in the CALGreen *Section A5.504.2.1: IAQ testing (2022)*.
 - a. Carbon monoxide maximum is 9 ppm, not to exceed outdoor levels by 2 ppm.
 - b. Formaldehyde maximum is 27 ppb.
 - c. Particulates maximum is 50 micrograms per cubic meter.
 - d. 4-Phenylcycohexene maximum is 6.5 micrograms per cubic meter.
 - e. Total VOC maximum is 300 micrograms per cubic meter.
3. For each sampling point where the maximum concentration limits are exceeded, take corrective action until air samples indicate compliance.
4. For each sampling point where airborne mold and mildew indoor species distribution varies by more than 10 percent from exterior sampling specification, identify source of mold and mildew and remediate with corrective action, then retest until compliant results are attained.
5. If noncompliant test results occur, provide a written report describing source(s) of noncompliant condition(s) and corrective action(s) implemented.

END OF SECTION 018113.71

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Owner's Project Requirements (OPR) and Basis of Design Document (BOD) are included by reference for information only.

1.2 SUMMARY

- A. Section Includes:
 - 1. General requirements for coordinating and scheduling commissioning activities.
 - 2. Commissioning meetings.
 - 3. Commissioning reports.
 - 4. Use of commissioning process test equipment, instrumentation, and tools.
 - 5. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
 - 6. Commissioning tests and commissioning test demonstration.
 - 7. Adjusting, verifying, and documenting identified systems and assemblies.

As applied to the commissioning requirements for mechanical (including building automation system), electrical, plumbing (MEPCx), renewable energy, and irrigation controls.
- B. Commissioning is a systematic process of verifying that the building systems perform interactively according to the construction documents and the Owner's operational needs. The commissioning process shall encompass and coordinate the system documentation, equipment startup, control system calibration, testing and balancing, performance testing, and training. Commissioning during the construction and post-occupancy phases is intended to achieve the following specific objectives according to the contract documents:
 - 1. Verify that the applicable equipment and systems are installed in accordance with the contract documents and according to the manufacturer's recommendations.
 - 2. Verify and document proper integrated performance of equipment and systems.
 - 3. Verify that Operations & Maintenance documentation is complete.
 - 4. Verify that all components requiring servicing can be accessed, serviced and removed without disturbing nearby components including ducts, piping, cabling or wiring.
 - 5. Verify that the Owner's operating personnel are adequately trained to enable them to operate, monitor, adjust, maintain, and repair building systems in an effective and energy-efficient manner.
 - 6. Document the successful achievement of the commissioning objectives listed above.
- C. Various sections of the project specifications require equipment startup, testing, and adjusting services. Requirements for startup, testing, and adjusting services specified in the technical sections of these specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.
- D. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning product.
- E. Related Requirements:
 - 1. SECTION 01 11 00: SUMMARY OF WORK
 - 2. SECTION 01 31 00: PROJECT COORDINATION
 - 3. SECTION 01 31 19: PROJECT MEETINGS
 - 4. SECTION 01 32 00: PROGRESS SCHEDULE AND REPORTS
 - 5. SECTION 01 33 00: SUBMITTAL PROCEDURES
 - 6. SECTION 01 45 00: QUALITY CONTROL
 - 7. SECTION 01 70 00: CONTRACT CLOSEOUT
 - 8. SECTION 01 78 00: PROJECT RECORD DOCUMENTS
 - 9. SECTION 01 78 23: OPERATION AND MAINTENANCE DATA

10. SECTION 01 79 00: DEMONSTRATION AND TRAINING
11. SECTION 01 81 13.15: SUSTAINABLE DESIGN REQUIREMENTS – LEED V4 BD+C
12. SECTION 01 81 13.71: CALGREEN NON-RESIDENTIAL MANDATORY MEASURES
13. DIVISION 22: PLUMBING – COMMISSIONING REQUIREMENTS APPLY TO THE SYSTEM(S) SHOWN IN SECTION 3.8 COMMISSIONED SYSTEMS, OF THIS DOCUMENT.
14. DIVISION 23: HEATING VENTILATING AND AIR CONDITIONING – COMMISSIONING REQUIREMENTS APPLY TO THE SYSTEM(S) SHOWN IN SECTION 3.8 COMMISSIONED SYSTEMS, OF THIS DOCUMENT.
15. DIVISION 26: ELECTRICAL – COMMISSIONING REQUIREMENTS APPLY TO THE SYSTEM(S) SHOWN IN SECTION 3.8 COMMISSIONED SYSTEMS, OF THIS DOCUMENT.
16. SECTION 32 84 00: PLANTING IRRIGATION

F. References

1. ASHRAE Standard 202-2024 Commissioning Process Requirements for New Buildings and New Systems.
2. ASHRAE Guideline 0-2019 The Commissioning Process.
3. ASHRAE Guideline 1.1-2007, HVAC&R Technical Requirements for the Commissioning Process.
4. ASHRAE Guideline 1.4-2019, Preparing Systems Manuals for Facilities.
5. 2022 California Green Building Standards Code, Title 24, Part 11 (CALGreen).
6. LEED™, New Construction Reference Guide.

1.3 DEFINITIONS

- A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- B. Acceptance Phase: Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.
- C. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.
- D. Architect/Engineer (A/E): The prime consultant (architect) and sub-consultants who comprise the design team. As it pertains to commissioning, the A/E is the design professional responsible for the design of the portion of the project being commissioned.
- E. Basis of Design (BoD) document: A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- F. Building Automation System (BAS): The central building control system and energy management system. Also referred to as a Controls System.
- G. Building Management System (BMS): In general practice, this is just a different name for the BAS.
- H. Commissioning (Cx): - A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements.
- I. Commissioning Activity Schedule: A commissioning schedule designed to provide team members with a descriptive overview of commissioning activities as they relate to parallel construction activities regardless of changes to the construction schedule. (See Exhibit B this specification and Cx Plan)
- J. Commissioning Authority (CxA): An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning Process. The CxA reports directly to the Owner without assuming oversight responsibilities.
- K. Commissioning Coordinator (CxC): A person or entity employed by the Contractor to manage, schedule and coordinate the commissioning process.
- L. Commissioning Plan (Cx Plan): A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Commissioning Process.
- M. Construction Manager (CM): Owner's on-site representative in day-to-day activities, including supervision and management of construction activities.

- N. Commissioning Team: The commissioning team is composed of key members from the Owner, the design team, the construction team, and critical equipment installers.
- O. Contract Documents: They include a wide range of documents that will vary from project to project and with the Owner's needs and regulations, laws, and countries, construction management process, subcontractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and other Construction Documents.
- P. Contractor (C) or General Contractor (GC): The person or entity under contract with the Owner pursuant to the Construction Contract to serve as the General Contractor for the construction work.
- Q. Control System: A component of environmental, HVAC, security and fire systems for reporting, monitoring and issuing of commands.
- R. Data Logging: Monitoring flows, currents, status, pressures, etc. of equipment using stand-alone data loggers separate from the control system.
- S. DDC: Acronym for Direct Digital Controls. This is the most typical controls platform for BAS' / BMS'.
- T. Deferred Functional Tests: Functional Tests that are performed later, after substantial completion, equipment, seasonal requirements, design, or other site conditions that disallow tests from being performed.
- U. Deficiency or Commissioning Issue: A condition identified by the Commissioning Agent or other member of the Commissioning Team that adversely affects the commissionability, operability, maintainability, or functionality of a system, equipment, or component. A condition that is in conflict with the Contract Documents and/or performance requirements of the installed systems and components.
- V. Factory Testing: Testing of equipment on-site or at the factory, by factory personnel with District's representative present.
- W. Facilities Manager (FM): The Owner representative responsible for the operation and maintenance of the physical facilities and grounds.
- X. Functional Performance Test (FPT): Test of the dynamic function and operation of equipment and systems using, simulations, manual (direct observation) and/or monitoring methods. Systems are tested under various modes. The systems are run through all the control system's sequences of operation and components are verified to be responding as intended per the specified sequence of operations. FPTs are performed after pre-functional checklists and startup is complete and are performed by the contractor and witnessed by the CxA.
- Y. Installation Verification: Observations or inspections that confirm the system or component has been installed in accordance with the contract documents and to industry accepted best practices.
- Z. Integrated System Testing: Integrated Systems Testing procedures entail testing of multiple integrated system's performance to verify proper functional interface between systems. Typical Integrated Systems Testing includes verifying that building systems respond properly to loss of utility, transfer to emergency power sources, re-transfer from emergency power source to normal utility source; interface between HVAC controls and Fire Alarm systems for equipment shutdown, interface between Fire Alarm system and elevator control systems for elevator recall and shutdown; interface between Fire Alarm System and Security Access Control Systems to control access to spaces during fire alarm conditions; and other similar tests as determined for each specific project.
- AA. Master Issues Log: A formal and ongoing record of problems or concerns, and their resolution, that have been raised by members of the commissioning team during the course of the commissioning process. Maintained by the CxA.
- BB. Monitoring: The recording of equipment operation parameters (flow, current, status, pressure, etc.) using data loggers or the trending capabilities of control systems.
- CC. Owner's Project Requirements (OPR): A collection of documents that details the functional requirements of Project and expectations of how it will be used and operated. This document includes Project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information.
- DD. Owner: Project Owner or designated representative.
- EE. Owner-Contracted Tests: Tests paid for by the Owner outside the Contract and for which the CxA does not oversee. These tests will not be repeated during functional tests if properly documented.

- FF. Overwritten Value: Writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50°F to 75°F to verify economizer operation). See also "Simulated Signal" in 3.3-E-1-C.
- GG. Phased Commissioning: Commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order minimize the total construction time.
- HH. Pre-functional Checklists (PFC): Checklists prepared by the CxA, in conjunction with the Subs, and provided to the contractor to document the complete installation of equipment or systems. These checklists are essentially elementary component tests to verify proper installation of equipment and are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, amp readings, etc.) Pre-functional checklists are completed by the contractors prior to or along with the manufacturer's start-up procedure and checklist.
- II. Pre-Functional Test (PFT): An inspection or test that is done before functional testing. PFT's include installation verification and system and component start up tests.
- JJ. Quality Assurance: The application of planned, and systematic methods to verify that quality control procedures are being effectively implemented. This is a set of processes and procedures that ensure a construction project meets quality and performance standards, regulations, and client expectations.
- KK. Quality Control: The process to establish consistency and conformance in project / program work that includes the continuous review, certification, inspection, and testing of project / program components including persons, systems, materials, documents, techniques, and workmanship to determine whether such components conform to the plans, specifications, applicable standards, and project / program requirements.
- LL. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment.
- MM. Seasonal Performance Tests: Functional Tests that are deferred until the system(s) will experience conditions closer to their design conditions.
- NN. Site Observation Visit: On-site inspections and observations made by the Commissioning Agent for the purpose of verifying component, equipment, and system installation, to observe contractor testing, equipment start-up procedures, or other purposes.
- OO. Start-up: The initial starting or activating of dynamic equipment or the initial energization and programming of control systems.
- PP. Systems Manual: A system-focused composite document that includes summary information required for the owners / operators to maintain and operate the system(s).
- QQ. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.
- RR. Test, Adjust, Balance (TAB): A systematic process or service applied to heating, ventilating, and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as "Testing, Adjusting, and Balancing" and are described in the Procedural Standards for the Testing, Adjusting and Balancing of Environmental Systems, published by NEBB or AABC.
- SS. Test Procedures: Written details developed by the CxA, and included in the FPTs, that details the expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.
- TT. Trends / Trending: Recordings of control point value history or monitoring value history over time. Trends are automatically recorded by the building automation system or other electronic data gathering equipment. Trend data gathered over a period of time is often used to analyze and verify proper performance of equipment, systems, or sequence of operations.
- UU. Training Plan: A written document that details the expectations, schedule and deliverables of commissioning process activities related to training of project operating and maintenance personnel, users and occupants.

- VV. Trending: The monitoring by a building management system or other electronic data gathering equipment and analyzing of the data gathered over a period of time to verify proper equipment or systems sequence of operations.
- WW. Warranty Phase Commissioning: Warranty Phase Commissioning efforts are executed approximately 10 months. after a project has been completed and accepted by the Owner is This Commissioning phase may include verification of system performance, measurement and verification tasks and assistance in identifying warranty issues and enforcing warranty provisions of the construction contract. See the Warranty section of this document for additional information.
- XX. Warranty Visit: A commissioning meeting and site review where all outstanding warranty issues and deferred testing is reviewed and discussed.

1.4 COMPENSATION

- A. If the Commissioning Authority is required to perform additional services or incur additional expenses due to actions of the Contractor as listed below the Contractor agrees to compensate the Owner for such additional services and expenses.
 - 1. Failure to provide timely notice of commissioning activities schedule changes.
 - 2. Failure to meet acceptance criteria for test demonstrations.
 - 3. Additional work required by the CxA to coordinate and correct commissioning issues.
 - 4. Additional work required to coordinate and repeat tests when equipment and systems fail initial acceptance criteria testing.
 - 5. See 3.11 Exhibit A: Commissioning Readiness Letter (CxRL).
- B. Contractor shall compensate Owner for such additional services and expenses at the rate of \$250.00 per labor hour, plus travel and per diem allowances for meals and lodging according to current U.S. General Services Administration (GSA) Per Diem Rates for the project area for the applicable fiscal year and month(s).

1.5 COMMISSIONING TEAM INTERACTION & PROCESS

- A. A project team will be created to coordinate the commissioning effort. This team will coordinate and communicate with the rest of the project team, attend meetings, and solve problems. This team includes representatives from the contractor, subcontractors, and owner.
- B. The prime contractor shall in addition to their representative also appoint a representative from each subcontractor involved in commissioned systems including mechanical, electrical, controls, test adjust balance, and plumbing systems.
- C. With these fundamental practices in mind, the commissioning process described herein has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Agent must develop effective methods to communicate with every member of the construction team involved in delivering commissioned systems while simultaneously respecting the exclusive contract authority of the Construction Project Manager (CM). Thus, the procedures outlined in this specification must be executed within the following limitations:
 - 1. No communications (verbal or written) from the Commissioning Agent shall be deemed to constitute direction that modifies the terms of any contract between the Owner and the Contractor.
 - 2. Commissioning Issues identified by the Commissioning Agent will be delivered to the Construction Manager and copied to the designated Commissioning Representatives for the Contractor and subcontractors on the Commissioning Team for information only in order to expedite the communication process. These issues must be understood as the professional opinion of the Commissioning Agent and as suggestions for resolution.
 - 3. In the event that any Commissioning Issues and suggested resolutions are deemed by the Construction Manager to require either an official interpretation of the construction documents or require a modification of the contract documents, the Construction Manager will issue an official directive to this effect.
 - 4. All parties to the Commissioning Process shall be individually responsible for alerting the Construction Manager of any issues that they deem to constitute a potential contract change prior to acting on these issues.

5. Authority for resolution or modification of design and construction issues rests solely with the Construction Manager, with appropriate technical guidance from the Architect/Engineer and/or Commissioning Agent.

1.6 OWNER'S RESPONSIBILITIES

- A. Participate in resolution of issues that may occur as a result of the commissioning process.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
 1. Coordination meetings.
 2. Training in operation and maintenance of systems, subsystems, and equipment.
 3. Testing meetings.
 4. Demonstration of operation of systems, subsystems, and equipment.
 5. Provide feedback to CxA for the project warranty phase testing and review, as well as access to the site and controls system during the warranty test.

1.7 COMMISSIONING COORDINATION RESPONSIBILITIES

- A. Contractor's and Subcontractor's Responsibilities
 1. Provide utility services required for the commissioning process.
 2. Contractor is responsible for construction means, methods, job safety, or management function related to commissioning on the job site.
 3. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
 - a. Participate in construction-phase commissioning meetings including controls coordination meeting to review and resolve any issues with the sequence of operations.
 - b. Participate in maintenance orientation and inspection.
 - c. Participate in operation and maintenance training sessions.
 - d. Certify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
 - e. Perform quality control of all work and certify it is complete prior to request for inspection.
 - f. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 4. Contractor shall integrate all commissioning activities into Contractor's master construction schedule.
 5. Contractor shall provide a means to effectively commission the BMS system including the following at minimum:
 - a. Schedule the controls contractor that was an integral part of programming the building BMS to run the tests
 - b. Provide a table with chairs
 - c. Provide a 17" 1080p monitor with 10' cables for connection to the controls contractor's laptop.
 6. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
 - a. Participate in construction-phase coordination meetings.
 - b. Participate in maintenance orientation and inspection.
 - c. Complete pre-functional checklists for all equipment. Submit completed forms with start-up reports immediately after start up.
 - d. Schedule and perform duct air leakage testing as specified in the technical specification sections. Make testing available for CxA to witness, and provide testing reports to CxA.
 - e. Provide flushing plans, disinfection reports and water treatment reports to the CxA for review.
 - f. Participate in pre-TAB meeting and jobsite inspections to verify TAB readiness.
 - g. Provide draft completed TAB report to CxA for review. CxA will identify up to 20% of TAB report for TAB contractor to demonstrate compliance to the completed TAB report.

- h. Participate in procedures meeting for testing.
 - i. Perform point-to-point, calibration and checkout of the building automation system and provide completed report to the CxA for review.
 - j. Participate in final review at acceptance meeting.
 - k. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.
 - l. Provide information to the CxA for developing construction-phase commissioning plan.
 - m. Participate in training sessions for operation and maintenance personnel.
 - n. Verify that all systems function correctly by testing each mode of operation, alarm and system function.
 - o. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified.
 - p. Perform quality control of all work and certify it is complete prior to request for inspection.
 - q. Complete and sign Commissioning Readiness Letter (CxRL) and provide to CxA (See EXHIBIT A of this specification section).
 - r. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures and participate in testing of installed systems, subsystems, and equipment.
 - s. Perform seasonal testing, at the direction of the CxA, to prove functional performance of the HVAC and controls in the opposite season.
- B. Architect and Design Engineer Responsibilities
- 1. Responsible for developing the construction contract documents and clarifying the design intent during the construction phase of the project.
 - 2. Performs construction observation.
 - 3. Contracted directly to OWNER.
- C. CxA's Responsibilities
- 1. Organize and lead the commissioning team.
 - 2. Prepare a Commissioning Plan. Collaborate with design team, owner, contractor and subcontractors to develop test and inspection procedures. Identify commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.
 - 3. Work with the Contractor to schedule commissioning activities. The Contractor shall integrate all commissioning activities into the master construction schedule. All parties will address scheduling issues in a timely manner in order to expedite the commissioning process.
 - 4. Review and comment on submittals for compliance with the approved project documents and identify any potential conflicts.
 - 5. Conduct commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes. The CxA shall prepare and distribute minutes to commissioning team members and attendees within five (5) workdays of the commissioning meeting.
 - 6. At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for permanent power; operation and maintenance data submittals; operation and maintenance training sessions; TAB Work; and Project completion.
 - 7. Periodically observe and inspect construction and report progress and deficiencies. In addition to compliance with the Contract Documents, inspect systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.
 - 8. Prepare Project-specific pre-functional checklists and functional test procedures checklists..
 - 9. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.
 - 10. Review and comment on operation and maintenance documentation for compliance with the Contract Documents. Operation and maintenance documentation requirements are specified in Division 01 Section "Operation and Maintenance Data."
 - 11. Review Contractor's operation and maintenance training program. Operation and maintenance training is specified in Division 01 Section "Demonstration and Training."
 - 12. Prepare commissioning status reports.
 - 13. Assemble the final commissioning documentation, including the Commissioning Report including applicable Project Record Documents.

1.8 COMMISSIONING DOCUMENTATION

- A. Commissioning Plan: A document, prepared by CxA, that outlines the process, schedule, allocation of resources, and documentation requirements of the commissioning effort, and shall include, but is not limited to the following:
1. Description of the organization, layout, and content of commissioning documentation to be provided along with identification of responsible parties.
 2. Identification of systems and equipment to be commissioned.
 3. Description of the level of commissioning for each system
 4. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
 5. Identification of items that must be completed before the next operation can proceed.
 6. Description of responsibilities of commissioning team members.
 7. Description of observations to be made.
 8. Description of requirements for operation and maintenance training, including required training materials.
 9. Provide a schedule for commissioning activities with specific dates coordinated with overall construction schedule.
 10. Define the process for completing pre-functional and startup checklists for systems, subsystems, and list of specific equipment requiring these checklists.
 11. Include Step-by-Step procedures for Functional Testing of systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.
- B. Pre-Functional Checklists: CxA shall develop pre-functional checklists for all equipment to be commissioned. Pre-Functional Checklists shall be completed and signed by the Contractor, verifying that systems, subsystems, equipment, and associated controls are ready for testing. The Commissioning Agent may spot check Pre-Functional Checklists to verify accuracy and readiness for testing. Inaccurate or incomplete Pre-Functional Checklists shall be returned to the Contractor for correction and resubmission.
- C. Site Visit Reports: CxA shall record test data, observations, and measurements on site visit forms. Updated Issues Log, photographs and other means appropriate for the application shall be included with Report.
- D. Start-Up Reports: Contractor/Manufacturer created forms that document that factory start-up procedures have been followed for all equipment and systems to be commissioned. Provided by sub-contractors.
- E. Functional Performance Testing: CxA shall develop functional performance test procedures for all equipment and systems to be commissioned. Site Visit Reports: CxA shall record test data, observations, and measurements on site visit forms. Photographs and other means appropriate for the application shall be included with data.
- F. Test and Inspection Reports: CxA shall compile test and inspection reports and test and inspection certificates and include them in Systems Manual and commissioning report.
- G. Commissioning Schedule: CxA shall review and provide input to the master project and construction schedules for commissioning activities.
- H. Issues Log: CxA shall prepare and maintain an issues log that describes installation, and performance issues that are at variance with the Contract Documents. CxA will identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.
1. Creating an Issues Log Entry:
 - a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
 - b. Assign a descriptive title of the issue.
 - c. Identify issue date.
 - d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
 - e. Identify system, subsystem, and equipment to which the issue applies.
 - f. Identify location of system, subsystem, and equipment.
 - g. Include information that may be helpful in diagnosing or evaluating the issue.
 - h. Note recommended corrective action.

- i. Identify commissioning team member responsible for corrective action.
 - j. Identify expected date of correction.
 - k. Identify person documenting the issue.
 2. Documenting Issue Resolution:
 - a. Log date correction is completed or the issue is resolved.
 - b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
 - c. Identify changes to the Contract Documents that may require action, if any.
 - d. State that correction was completed and system, subsystem, and equipment are ready for retest, if applicable.
 - e. Identify person(s) who corrected or resolved the issue.
 - f. Identify person(s) documenting the issue resolution.
- I. Commissioning Report: CxA shall document results of the commissioning process including performance of systems, subsystems, equipment and issues. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the OPR, BOD and Contract Documents. The commissioning report shall include, but is not limited to, the following:
 1. Discussion of performance of commissioned systems including any variance from OPR, BOD and the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during OWNER occupancy and operation. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
 2. Commissioning Plan.
 3. Testing plans and reports.
 4. Issues log.
 5. Completed test checklists.
 6. Listing of off-season test(s) not performed and a schedule for their completion.
- J. Systems Manual: CxA shall gather required information and compile Systems Manual. Systems manual shall include, but is not limited to, the following:
 1. As-built system narratives, schematics, and list of installed equipment
 2. Operation and maintenance data

1.9 CXA SUBMITTALS

- A. Commissioning Plan: CxA shall submit a draft commissioning plan. Deliver one copy to Contractor and one to OWNER. Present submittal in sufficient detail to evaluate data collection and arrangement process. One copy, with review comments, will be returned to the CxA for preparation of the final commissioning plan.
- B. Pre-functional Checklists: CxA shall submit sample checklists and forms to Contractor and subcontractors for review, comment and approval. Contractor completed prefunctional checklists are required to be submitted for review and approved prior to proceeding with functional performance testing.
- C. Functional Test Plan: CxA shall submit draft Functional Test Plan and checklists for comment. The final Functional Test Plan will be submitted and used for functional testing.
- D. Site visit reports: CxA shall submit site visit reports as they are created.
- E. Final Commissioning Report: CxA shall submit the draft commissioning report. One copy, with review comments, will be returned to the CxA for preparation of final submittal. The final report submittal must address previous review comments.
- F. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires facilitating the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum the request will include the manufacturer and model number, the manufacturer printed installation and detailed start-up procedures, sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details. In addition, the factory checkout sheets or field technicians' reports shall be submitted for review

1.10 COORDINATION

- A. Scheduling: The Contractor shall work with the Commissioning Agent to incorporate the commissioning activities into the construction schedule. The Commissioning Agent will provide sufficient information (including, but not limited to, tasks, durations and predecessors) on commissioning activities to allow the Contractor to schedule commissioning activities. All parties shall address scheduling issues and make necessary notifications in a timely manner in order to expedite the project and the commissioning process. The Contractor shall update the Master Construction schedule as directed by the Owner.
- B. Coordinating Meetings: CxA shall conduct coordination meetings of the commissioning team as needed to review progress on the commissioning plan, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- C. Pretesting Meetings: CxA shall conduct pretest meetings with the commissioning team to review startup reports, coordinate controls sequence of operations, review pretest inspection results, review testing and balancing procedures, review testing personnel and instrumentation requirements, and manufacturers' authorized service representative services for each system, subsystem, equipment, and component to be tested.
- D. Testing Coordination: CxA shall coordinate with the OWNER and Contractor to plan the sequence of testing activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- E. The Subcontractors shall provide sufficient notice to the CxA (2 weeks minimum) regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The contractor will use the Commissioning Readiness Letter (CxRL) in EXHIBIT A to notify the CxA that the systems are ready.
- F. General
 - 1. Functional testing is conducted after pre-functional testing and startup has been satisfactorily completed.
 - 2. The BAS is sufficiently tested and approved by the CxA before it is used for TAB or to verify performance of other components or systems.
 - 3. The air and water balancing is complete and approved before functional testing of air-related or water-related equipment or systems.
 - 4. Testing proceeds from components to subsystems to systems.
 - 5. When the proper performance of all interacting, individual systems has been achieved, the interface or coordinated responses between systems is checked.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT AND DOCUMENTATION, INSTRUMENTATION AND TOOLS

- A. Test equipment and instrumentation required to perform the commissioning shall remain the property of Contractor unless otherwise indicated.
- B. Test equipment and instrumentation required to perform commissioning shall comply with the following criteria:
 - 1. Be manufactured for the purpose of testing and measuring tests for which they are being used and have an accuracy to test and measure system performance within the tolerances required to determine acceptable performance.
 - 2. Calibrated and certified.
 - a. Calibration performed and documented by a qualified calibration agency according to national standards applicable to the tools and instrumentation being calibrated. Calibration shall be current according to national standards or within test equipment and instrumentation manufacturer's recommended intervals, whichever is more frequent, but not less than within Six [6] months of initial use on Project. Calibration tags permanently affixed.

- b. Repair and recalibrate test equipment and instrumentation if dismantled, dropped, or damaged since last calibrated.
3. Maintain test equipment and instrumentation.
4. Use test equipment and instrumentation only for testing or monitoring Work for which they are designed.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. The CxA shall provide the Design Builder with a specific request for the type of submittal documentation required to facilitate the commissioning work. These requests shall be integrated into the submittal process and protocol of the project.
- B. The submittal shall be reviewed and approved by the Design Builder's design team prior to being submittal to the CxA.
- C. At minimum, the submittal request shall include:
 1. Equipment manufacturer and model number.
 2. Selection and operating data (Example: Flows, pressures, temperatures, fan curves, etc.).
 3. The manufacturer's printed installation and detailed start-up procedures.
 4. Full sequences of operation and control drawings.
 5. O&M data, performance data, performance test procedures, details, and results of owner-contracted tests.
 6. Installation and checkout materials that are shipped inside the equipment and the manufacturer field checkout sheet forms to be used by the factory or field technicians.
- D. The CxA shall review and approve submittals related to the commissioned equipment for conformance to the Owner Project Requirements, Design documents and as it relates to the commissioning process, the functional performance of the equipment, completeness and adequacy for developing test procedures.
- E. The CxA's review is intended to aid in the development of functional testing procedures and to verify compliance with equipment specifications. The Commissioning authority shall notify the Owner and the DBB of items missing or areas that are not in conformance with contract documents or Owner Project Requirements and which require resubmission.
- F. The CxA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the basis of design documentation and sequences provided with the design document Specifications.
- G. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Design Bid Builder, though the CxA will review and approve them.

3.2 PRE-FUNCTIONAL CHECKLISTS AND FACTORY START UP REPORTS

- A. The following procedures apply to all equipment to be commissioned.
- B. Pre-functional Checklists are developed by the CxA and completed by the appropriate installing contractors for all major equipment and systems being commissioned before functional testing can begin. The checklist captures equipment nameplate and characteristics data, confirming the as-built status of the equipment or system. These checklists also ensure that the systems are complete and operational, so that the functional performance testing can be scheduled. The Contractor and vendors shall execute factory startup and provide the CxA with a copy of the signed and dated completed start-up checklists which will be submitted with the Pre-Functional checklists.
- C. Startup and Initial Checkout Plan: The Contractor shall develop detailed startup plans for all equipment. The primary role of the Contractor in this process is to ensure that there is written documentation that each of the manufacturer recommended procedures have been followed and completed. Parties responsible for startup shall be identified in the Startup Plan and in the checklist forms.
 1. The full startup plan shall at a minimum consist of the following items:
 - a. The Pre-Functional Checklists.

- b. The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - c. The manufacturer's normally used field checkout sheets.
 - D. The Commissioning Agent will review/approve the full start-up plan.
 - E. Execution of Pre-functional Checklists and Startup.
 - 1. Pre-Functional checklists will be provided to the project site by the CxA.
 - 2. The contractor shall maintain a master copy of signed checklists.
 - 3. The installing contractors shall update the checklists as work is completed. Only individuals that have direct knowledge and witnessed that a line-item task on the pre-functional checklist was actually performed shall initial or check that item off.
 - 4. The CxA will periodically review the checklists for completeness and report on progress at the Cx meetings.
 - F. BAS Startup Testing, Adjusting, and Calibration
 - 1. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:
 - a. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance.
 - b. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
 - c. Verify integrity/safety of all electrical connections.
 - d. Coordinate with TAB subcontractor to fine tune control settings that are determined from balancing and testing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS, Pre-functional checklists and initiate an associated Action Item:
 - 1) Optimum duct static pressure setpoints for VAV air handling units.
 - 2) Minimum outside air damper settings for air handling units.
 - 3) Optimum differential pressure setpoints for variable speed pumping systems.
 - 4) Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.
 - 5) BAS contractor shall provide access to the front end Building Automation System as a minimum to the TAB and CxA to facilitate calibration. Connection for any given device shall local to it (i.e.: at the VAV box or at the thermostat). Shall be made at front end and shall allow querying and editing of parameters required for proper calibration and start up.
 - e. Test, calibrate, and set all digital and analog sensing, and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/- 0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Pre-functional Report.
 - f. Check each digital control point by making a comparison between the control command at the controller and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the operator interface display. Record the results for each device in the BAS Pre-functional checklists.
 - g. Verify proper sequences by using the approved checklists to record results and submit with BAS Pre-functional checklists. Verify proper sequence and operation of all specified functions. There is inherent duplication between the functional performance testing of the Testing Contractor, and the thorough checking testing of the sequences by the BAS. Generally, the sequence checkouts indicated as the responsibility of the Testing Contractor under functional testing, must first be tested by the BAS under prefunctional testing.
 - h. Verify proper systems operation under emergency power. Cooperate and coordinate with Testing Contractor and CxA for comprehensive building power outage tests.
 - i. Verify all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
 - j. Verify that all alarm thresholds for all analog devices are entered. Request direction from Owner as to alarm threshold parameters.

- k. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Prefunctional Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 2 minutes of any upset (for which the system has the capability to respond to) in the control loop, tolerances shall be maintained (exceptions noted):
 - 1) Duct air temperature: $\pm 1^{\circ}\text{F}$.
 - 2) Space Temperature: $\pm 2^{\circ}\text{F}$
 - 3) Hot water temperature: $\pm 2^{\circ}\text{F}$.
 - 4) Duct pressure: $\pm 0.25''$ w.g.
 - 5) Water pressure: ± 1 psig
 - 6) Air flow control: $\pm 5\%$ of setpoint velocity. For min OA flow loops being reset from CO₂, response to upset max time is one hour
 - 7) Space Pressurization (on active control systems): $\pm 0.02''$ w.g. with no door or window movements
- G. For interface and DDC control panels:
 1. Ensure devices are properly installed with adequate clearance for maintenance and clearly labeled in accordance with the record drawings
 2. Ensure terminations are safe, secure and labeled in accordance with the record drawings
 3. Check power supplies for proper voltage ranges and loading.
 4. Ensure wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
 5. Check for adequate signal strength on communication networks.
 6. Check for stand-alone performance of controllers by disconnecting the controller from the LAN. Verify the event is enunciated at operator interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
 7. Ensure that controller memory and control network through-put are adequate to support the extensive trending requirements. Reconfigure the system to provide a reliable and robust system as necessary.
 8. Ensure all outputs and devices fail to their proper positions/states.
 9. Ensure buffered and/ or volatile information is held through power outage.
 10. With all system and communications operating normally, sample and record update/enunciation times for critical alarms fed from the panel to the operator interface.
 11. Check for adequate grounding of all DDC panels and devices.
- H. Meters
 1. All meters (Electric, Gas, Water) calibration will be verified in the field after installation.
 2. All Meters will be verified by the contractor to be reporting correctly; including – correct units, intervals, and trending back to the DDC controls system operator workstation graphics.
- I. For Operator Interfaces:
 1. Verify all elements on the graphics are functional and properly bound to physical devices and/or virtual points and that hot links or page jumps are functional and logical.
 2. Output all specified system reports for review and approval.
 3. Verify the alarm printing and logging is functional and per requirements
 4. Verify trend archiving to disk and provide a sample to the CxA for review.
 5. Verify paging/dial out alarm enunciation is functional.
 6. Verify functionality of remote operator interfaces and that a robust connection can be established consistently.
 7. Verify that required third party software applications required with the bid are installed and functional.
 8. Verify proper interface with fire alarm system.
- J. Submit Start-Up Test Report. Report shall be completed, submitted and approved prior to functional testing.
- K. Deficiencies, Non-Conformance and Approval in Checklists and Startup.
 1. The Contractor shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully, at the bottom of the procedures form or on an

- attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA reviews the report and reports to the OWNER. The CxA shall work with the Contractor and vendors to correct and retest deficiencies or uncompleted items.

3.3 FUNCTIONAL PERFORMANCE TESTING

A. Common Elements for All Systems

1. Have the required submitted documentation convenient to testing area. Validate that all required documentation has been submitted and is per the contract requirements (very cursory review). CxA shall review the content of the documentation and validate that it is per contract documents.
2. CxA shall review the startup documentation at the start of functional performance testing. Review the startup tests and checklist documentation. CxA shall validate that startup is acceptably executed and complete. CxA shall ensure that any items indicated as outstanding in the checklists is entered as an Action Item and enter one if it is not. The checklists and start up tests/measurements shall be spot checked at the beginning of FPT to ensure accuracy. CxA shall complete a test that indicates he has reviewed the prefunctional checklists and finds them acceptable and note any outstanding items.
3. CxA shall check for and as applicable direct Contractor to demonstrate that access is sufficient to perform required maintenance.
4. CxA shall validate that all prerequisite work is complete and confirm via a test record that the CxA feels it is.
5. Specifically check labeling and ensure conformance to contract requirements.
6. Check proof indication, alarming on failure and restart/acknowledgement as applicable.
7. CxA shall observe operating conditions encountered at the start of FPT. CxA shall examine for normal functionality and record parameters as a test.
8. All dynamic systems powered by electricity shall be tested to simulate a power outage to ensure proper sequencing. Those on emergency power or uninterruptible power shall be tested on all sources.
9. CxA shall inspect the installation and compare it to contract requirements. Record the inspection as a test.
10. Capacities and adjusted and balanced conditions as applicable will generally be checked.
11. Verify all sequence modes and sequences of operation. CxA must initiate all modes and may not refer to or rely on a prefunctional test done by the BAS. Some examples of generic modes that apply to most systems include:
 - a. Off Mode
 - b. Failed Mode: Proof, safeties, power outage etc. See below for stress testing.
 - c. Start Sequence in various modes
 - d. Stop sequences in various modes
12. All adjusted, balanced, controlled systems shall be assessed to determine the optimal setting for the system as applicable. The optimal settings should be determined to establish reliable, efficient, safe and stable operation. CxA is responsible for placing systems in optimal condition for occupancy and not simply relying on initial design estimated settings. For adjustable setpoints, the team will document the conditions at the end of FPTs. The contractors will use RFIs / ACDs to confirm any deviations from the design.
13. Dynamic Graphics: The graphic for all components, systems, and areas sampled and required to be represented by a graphic shall be checked for adequacy and accuracy. Furthermore, when setpoints are required to be adjustable, verify that they can be adjusted directly from the graphic screen.
14. All interfaces between two systems or equipment of different manufacturers must be checked for accuracy and functionality.
15. "Stress Testing": CxA shall analyze systems to identify possible conditions where functionality may be compromised. CxA shall design non-destructive tests that will demonstrate either the automated response to the conditions or so that team can identify the best method for responding or fixing the condition. All tests and findings shall be documented.

- #### B. Objectives and Scope.
- The objective of functional performance testing is to demonstrate that each system is operating according to the Contract Documents. Each system will be tested to verify that the system response is as designed. HVAC systems will be checked for conformance to the design sequences of operation and stable control, lighting control will be checked in each type of lighting area,

- security system cameras will be verified functional and able to see the correct areas. Proper system responses to such conditions as power failure, out of limit condition, equipment failure, etc. shall also be tested.
- C. Early duct air leakage tests shall be performed as specified to ensure green and building code compliance. Make testing available for CxA to witness, and provide testing reports to CxA. Point-to-point testing will be performed by controls contractor on all applicable systems, with results given to CxA prior to functional performance testing.
- D. Development of Test Procedures: The test procedures are written by the CxA based upon the final operational sequences from available project documentation. The CxA shall develop specific test procedures and forms to verify and document proper operation of each system. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection. The test procedure checklists developed by the CxA shall include the following information:
1. System and equipment or component name(s).
 2. Equipment location and ID number.
 3. Date.
 4. Project name.
 5. Participating parties.
 6. Reference to the specification section describing the test requirements, if applicable.
 7. A copy of the specific sequence of operations.
 8. Prerequisites for the test.
 9. Special cautions, alarm limits, etc.
 10. Specific step-by-step procedures to execute the test.
 11. Acceptance criteria of proper performance with a Yes / No/NA check box.
 12. A section for comments.
- E. Test Methods.
1. Systems Functional Performance Testing shall be achieved by manual testing (i.e., persons manipulate the equipment and observe performance) and/or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by standalone data loggers. The Contractor and Commissioning Agent shall determine which method is most appropriate for tests that do not have a method specified.
 - a. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, although timing the testing to experience actual conditions is encouraged wherever practical.
 - b. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
 - c. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
 - d. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. . For example, to see the Air Conditioning compressor lockout initiate at an outside air temperature below 54 F (12 C), when the outside air temperature is above 54 F (12 C), temporarily change the lockout setpoint to be 4 F (2 C) above the current outside air temperature.
 - e. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification shall be completed during systems startup and initial checkout

2. Functional testing is performed by the contractors with the method and degree of testing as defined in this specification for each system. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems to their pre-test condition.
3. Multiple identical pieces of equipment may be functionally tested using a sampling strategy. The sampling strategy will be defined in these specifications with the commissioned systems list.

- F. Coordination and Scheduling: See the *COORDINATION* section for coordination and scheduling details.
- G. Problem Solving: The CxA will recommend solutions to problems found; however, the burden of responsibility to solve, correct and retest problems is with the Contractor and Owner's consultants.

3.4 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

- A. Before the operation and maintenance training, CxA shall review training preparation for compliance with project documents.
- B. Training is required per contract specifications. At a minimum, training is required for Mechanical systems, Lighting, and Controls systems.
- C. The CxA requires submission of training records including attendance lists to verify appropriate people received the training.

3.5 GENERAL WARRANTY REQUIREMENTS

- A. Coordinate MEP Contractor Call-back and Warranty Enforcement.
 1. Perform review of commissioned systems:
 - a. Timed at approximately 2 months prior to the expiration of the project warranty period.
 - b. Project warranties have a typical duration of 12 months. Verify for this project.
 - c. The Warranty Period walk through inspection for the commissioned systems would then be typically scheduled at 10 months and should include representatives from the Owner, A/E, Facilities Management, CM, GC, subcontractors and manufacturers.

3.6 MEP Cx WARRANTY AND SEASONAL TESTING REQUIREMENTS

- A. The Warranty Phase of a project can incorporate one or both of these two complimentary activities:
 1. Seasonal Testing: Seasonal variation in operations or control strategies may require additional testing during peak cooling and heating seasons to verify systems performance. If the project finishes in the summer, testing of the heating systems may not be effective or conclusive, and can be postponed to colder weather if seasonal testing is included in the scope. The CxA coordinates this activity. Tests are executed and deficiencies corrected by the appropriate subcontractors, witnessed by Owner's staff and the CxA.
 2. Warranty Testing: The CxA will perform an evaluation of the systems in the Cx scope to provide additional experienced review of operation prior to the expiration the warranty. The CxA will request input from the Owner's operations staff and occupants about the performance of the building systems, as well as perform targeted evaluation of systems and controls. Additionally, open items on the Master Issues Log are often reviewed for completion, or significant issues observed during previous phases are evaluated to ensure they are still in a corrected state. A warranty walk review typically is performed onsite. However, videoconference and BMS remote review by the CxA may be arranged in place of the onsite warranty walk.
- B. These two activities often have overlapping scope and intent and will be performed during the same site evaluation(s), where possible.
- C. The warranty period typically begins at the project's Substantial Completion or shortly thereafter.

3.7 COSTS OF COMMISSIONING WORK

- A. The cost to the Contractor and Subcontractors to comply with the specified requirements and to support the work of the CxA shall be included in the Contractor's and Subcontractor's bid price.
- B. It is the Contractor's responsibility to QC and pre-test all building equipment and systems. The CxA shall confirm function of each system. If a device, piece of equipment, sequence, or system fails a test, corrections shall be made immediately and retested.
- C. If at any point in the Commissioning Functional Testing Process, should an issue or failure arise that requires significant time to correct or cannot be corrected immediately during the testing process, that results in a delay or prevents the CxA from completion of the functional testing, incurred costs shall be reimbursed by the Contractor. The associated costs of re-testing are defined in Exhibit A - Commissioning Readiness Letter (CxRL).

3.8 COMMISSIONED SYSTEMS (To be revised with updated Mechanical drawings)

System	Equipment	Level Note
HVAC	Pumps	5
	Heat Exchangers	5
	Energy Recovery Units	5
	Outside Air Ventilation Systems / Dedicated Outside Air System (DOAS)	5
	Supply Fans	3
	Split Systems	3
	Fan Coil Units	3
	Air Cooled Condensing Units (Split and FCU)	3
	Variable Frequency Drives	3
	Exhaust Fans	3
	VAV Air Terminal Units	3
	CAV Air Terminal Units	3
	Test Adjust Balance Report Values	3
Building Management System	Sequences of Operation, Monitored Points, and Alarms	5
	Metering/Monitoring Devices and Equipment	5
	Software Commissioning, GUI Presentation Commissioning, System Access Performance Criteria, Software Tools/Source Code Commissioning, Instrument Data Sheets, Middleware Commissioning, Internet Protocol Commissioning	5
Electrical System	Lighting Systems & Controls (Interior & Exterior & Emergency Functions)	3
	Switchgear & Distribution Panels	2
Plumbing System	Domestic Water Heaters	5
	Industrial Water Heaters	5
	Thermostatic Mixing Valves	5
	HW Circulation Pump	5
Irrigation	Irrigation Controls	5

Testing Levels Defined:

Level 1 - The CxA will request and review equipment installation documentation, periodically observe and review the installation of building systems to verify that the operation meets the Owners Project Requirements.

Level 2 - The CxA will perform Level 1 activities and will witness Contractor performance testing of the system. Contractor shall test systems at the discretion of the CxA to prove operational requirements are met. The test sections shall be chosen at random by the CxA to ensure uniformity of system. Testing failures may result in Level 3 testing.

Level 3 - The CxA will perform Level 2 activities and will witness contractor performance testing of the system. Contractor shall test up to 20% of the system to prove operational requirements are met. The test sections shall be chosen at random by the CxA to ensure uniformity of the system. Failure of any test section shall require retesting of that section and an additional test section equivalent in scope. Coordination will be required to avoid impact to the construction schedule.

Level 4 - The CxA will perform Level 2 activities and will witness contractor performance testing of the system. Contractor shall test up to 50% of the system to prove operational requirements are met. The test sections shall be chosen at random by the CxA to ensure uniformity of the system. Failure of any test section shall require retesting of that section and an additional test section equivalent in scope. Coordination will be required to avoid impact to the construction schedule.

Level 5 - The CxA will perform Level 2 activities and will witness contractor performance testing of the system. Contractor shall test up to 100% of the system to prove operational requirements are met. Failure of any test section shall require retesting of that section. Coordination will be required to avoid impact to the construction schedule.

* Testing percentages may vary based on testing success rate.

3.9 METHODS OF TESTING

A. HVAC Systems

1. CxA may witness specified duct air leakage testing during rough-in. Contractor to forward all duct air leakage reports to CxA for review.
2. CxA will visit the site during rough-in of ductwork, piping and equipment to verify proper maintenance clearances and access are being maintained.
3. The CxA may witness contractor and/or factory start-up of equipment.
4. The TAB contractor shall re-measure up to 20% of the TAB report values for the CxA to observe and to verify balance values are within allowable design tolerances.
5. Stand-alone controls will be tested independent of item B below.
6. Contractor will demonstrate to the CxA that the operation of each system through all modes, alarms, and operating parameters meet the contract documents.

B. Building Management System

1. After receipt of the controls contractor's calibration and point to point reports by the CxA, the controls contractor will re-measure some of the points for the CxA to verify that the calibration and communication is correct. The points to be verified will be selected by the CxA.
2. Controls contractor shall provide an as-built shop drawing to the CxA for use in executing FPT.
3. All of the user graphics interfaces and displayed operating points will be demonstrated for the CxA by the controls contractor.
4. Controls contractor shall manipulate the system to demonstrate that it performs all of the specified modes of operation.
5. Points selected by the CxA will be trended for 1-2 weeks by the controls contractor to verify control operation and response. System needs to be in auto without alarms.

C. Electrical Systems

1. During the installation the CxA will perform the following for the electrical systems:
 - a. Periodically observe the installation of equipment.

- b. Review the completed Pre-functional Checklists (PFC).
 - c. Verify the PFC's by observing the completed work and comparing to the values listed in the PFC.
 - d. Review the factory authorized programming and checkout report of the lighting control panels and devices.
 - e. The contractor is to provide NETA (InterNational Electrical Testing Association) certified third party testing of the power distribution system and provide the CxA with a certified test report.
 - f. CxA will review contractor provided as-builts for proper identification and labeling of all equipment, piping and devices.
2. To test the performance of the lighting control system the CxA will perform the following tasks:
 - a. Witness the contractor testing each scene from each wall station.
 - b. Verify these scenes match the design intent from the contract documents.
 - c. Witness the contractor testing the integration to the other integrated systems such as audio visual and monitoring abilities from the BMS.
 - d. Verify this integration allows control and/or monitoring from the other systems.
 3. Upon completion of the emergency power system, factory start-up and contractor pretesting, the CxA will witness a contractor test to verify complete system power loss and verify proper power provision of critical systems. The test will not be scheduled until all other systems dependent on emergency power have been tested and approved.
- D. Plumbing
1. Domestic and industrial hot water will be tested by the CxA by measuring the hot water temperature at a percentage of the fixtures along with the time it takes to reach that temperature.
 2. Contractor shall demonstrate domestic hot water boilers, pumps and controls through all modes of operation and alarms.
 3. Contractor shall demonstrate to the CxA that the sanitary sewer and domestic booster pump operation through all modes and alarms meets approved sequence of operations.
 4. After contractor has adjusted all fixtures for proper flush and sink fixture metering, the CxA will test plumbing fixtures for proper operation.
 5. The contractor shall demonstrate the water management system to the CxA.
 6. The CxA will test the compressed air and vacuum systems for proper operation.
- E. Irrigation
1. The CxA will witness the contractor demonstration of the irrigation controller and coverage using the contractor's as-built drawings.

3.10 COST OF RE-TESTING AND COMMISSIONING READINESS LETTER (CxRL) – SYSTEMS FUNCTIONAL TESTING READINESS CERTIFICATION AND NOTIFICATION

- A. If CxA arrives onsite, on the scheduled date for functional testing (as indicated on the CxRL, see Exhibit A of this specification section) which cannot be completed due to systems readiness failure, systems technician no-show, or other circumstances not caused by CxA resulting in failed functional testing; it is understood that the CxA's client (listed on CxRL) will be invoiced for expenses incurred by CxA. The contractor also agrees to reimburse said client for incurred expenses. CxA expenses will be invoiced as noted in the CxRL.
- B. It is the Contractor's responsibility to QC and pre-test all building equipment and systems. The CxA shall confirm function of each system. If a device, piece of equipment, sequence, or system fails a test, corrections shall be made immediately and retested. Corrections that cannot be corrected immediately or that delay completion of CxA testing shall be reimbursed by the Contractor.

3.11 Exhibit A: Commissioning Readiness Letter (CxRL) - Systems Functional Testing Readiness Certification and Notification

Las Positas College / Building 1500/1800
 3000 Campus Hill Drive, Livermore, CA 94551

This letter shall serve as certification to 3QC that all applicable systems checked below have been fully tested to perform as specified in the Construction Documents, in accordance with 3QC's Functional Testing Checklists, and that all functional testing prerequisites as outlined in the Commissioning Specifications and Commissioning Plan have been completed and submitted to 3QC for review. 3QC is hereby officially notified to begin onsite functional testing of the following systems:

Systems Ready for Functional Testing by 3QC <i>(Completed by General Contractor or CM at Risk as systems become available and are ready for testing and meeting all criteria explained here within – Check only the systems that are ready at this time, use additional copies of this letter if needed as systems become ready.)</i>		
Check Applicable System	Systems	Date GC is Requesting for CxA on-site Functional Testing *
<input type="checkbox"/>	TAB Verification	
<input type="checkbox"/>	BMS, BAS, DDC or EMS	
<input type="checkbox"/>	HVAC Systems	
<input type="checkbox"/>	Plumbing Systems	
<input type="checkbox"/>	Lighting Control Systems	
<input type="checkbox"/>	Renewable Energy Systems	
<input type="checkbox"/>	Irrigation	

*** = Systems Technician Required** – The contractor certifies that a systems technician familiar with and capable of operating each system to be commissioned will be available onsite throughout functional testing by 3QC. For BMS, BAS, DDC or EMS systems this must be the commissioning technician/programmer.

Failed Functional Testing – If the CxA arrives onsite, on the date(s) indicated above, for functional testing of identified system(s) and cannot be tested due to systems readiness failure, systems technician no-show, or other circumstances not caused by 3QC resulting in failed functional testing; it is understood that 3QC's client (listed below) will be invoiced for travel and expenses incurred by 3QC. The Contractor agrees to reimburse project Owner for incurred expenses as described in Specification Section 019113, 1.4 COMPENSATION, B.

Signature of 3QC's Client or Representative	Print Name	Date

Signature of General Contractor or CM at Risk	Print Name	Date

3.12 Exhibit B: Commissioning Activity Schedule

Commissioning Activity Schedule							
GC Baseline Schedule Activity ID #	Commissioning (Cx) Construction Phase Activity		Building System		Parallel Construction Site Activity	Duration of Cx Activity	CxA Required Site Visit
			MEPCx				
1	Cx Kick-off Meeting		•		Contractor mobilized onsite	1 day	•
2	CxA provides a digital jobsite Cx Plan Binder with Pre-Functional Checklists to CM or Contractor		•		CM or GC to receive Cx Plan & PFC binder from CxA 1 month prior to MEP equipment startup	-	
3	CxA identifies submittals required for Cx		•		Contractor provides a submittal list for CxA review	-	
4	CxA reviews submittals		•		A/E reviews submittals	-	
5	CxA begins to receive O & M Manuals		•		Subcontractors send O & M Manuals to Contractor	TBD	
6	CxA performs site verification of mechanical equipment, and makes updates to Cx Equipment List & Cx Master Issues Log		•		Mechanical equipment set	1 day	•
7	CxA starts development of Cx Functional Test Checklists		•		Submittal reviews complete. <i>Note: Approved control submittal, with Sequences of Operation, is required to start MEP Cx Functional Test Checklists</i>	14 days	
8	CxA notified that permanent power is installed		•		Permanent power installed	-	
9	CxA receives copies of the field Duct Leakage Testing Reports		•		Duct leakage testing completed (if required)	-	
10	CxA conducts onsite functional testing procedures coordination meeting with CM, GC, MEP, communications, and security subcontractors		•		1 Month prior to Cx Functional Testing	1 day	•
11	CxA issues Functional Test Plan & Checklists to CM, GC, MEP, communications, and security subcontractors		•		1 Month prior to Cx Functional Testing	-	
12	CxA reviews start up reports and may witness startup of HVAC equipment.		•		GC sends completed startup reports	TBD	
13	CxA receives jobsite Pre-Functional Checklist Binder w/ completed, signed, and dated checklists		•		Completed Pre-Functional Checklists 2 Weeks prior to Cx Functional Testing	-	
14	Building LEED flush-out schedule received by CxA (if applicable)		•		CM or GC coordinates LEED flush-out schedule prior to Cx functional testing activities	-	

Commissioning Activity Schedule							
GC Baseline Schedule Activity ID #	Commissioning (Cx) Construction Phase Activity		Building System		Parallel Construction Site Activity	Duration of Cx Activity	CxA Required Site Visit
			MEPCx				
15	CxA receives field TAB Report reviewed and approved by Engineer of Record		•		1 Week prior to Cx Functional Testing	-	
16	CxA notified that Controls System is complete, and receives controls point to point testing report.		•		Equipment and systems to be under command of the Building Management System (BMS) and controls graphics complete. Point to Point controls testing complete.	-	
17	CxA receives completed/signed Commissioning Readiness Letter (CxRL) indicating Commissioned Systems are ready for Cx Functional Testing		•		1 Week prior to Cx Functional Testing	-	
18	CxA starts Functional Performance Tests (FPTs) on TAB, BMS, HVAC, domestic hot water, lighting controls, PV, and Irrigation Control Systems.		•		FPTs are scheduled after CxA receives the following functional testing prerequisites: a. Pre-functional checklist completed and signed b. EOR Approved TAB report c. Equipment and systems to be under command of the Building Management System (BMS) and controls graphics complete d. Signed CxRL that commissioned systems are completed and ready for Cx functional testing	5 total days of items 19 thru 25	
19	CxA verification of the TAB report air and water balance values		•		TAB, Controls, and Mechanical subcontractors meet CxA onsite to verify TAB report	1 day	•
20	CxA FPTs of BMS		•		Controls subcontractor meets CxA onsite to perform Functional Testing of BMS after BMS point-to-point and QC checkout is completed	1/2 day	•
21	CxA FPTs of HVAC		•		Controls and Mechanical subcontractors meet CxA onsite to perform functional testing of HVAC systems	2 days	•
22	CxA FPTs of Domestic Water and Domestic Hot Water		•		Plumbing subcontractor meets CxA onsite to perform functional testing of domestic cold and hot water	1/2 day	•

Commissioning Activity Schedule							
GC Baseline Schedule Activity ID #	Commissioning (Cx) Construction Phase Activity		Building System		Parallel Construction Site Activity	Duration of Cx Activity	CxA Required Site Visit
			MEPCx				
23	CxA FPTs of Lighting Controls		•		Lighting Control and Electrical subcontractors meet CxA onsite to perform functional testing of lighting controls	1/2 day	•
24	CxA FPTs of Irrigation Controls		•		Irrigation subcontractor meets CxA onsite to perform functional testing of irrigation controls and systems	1/2 day	•
25	CxA FPTs of Photovoltaic (PV) Solar Panels		•		PV and Electrical subcontractors meet CxA onsite to perform functional testing of irrigation controls and systems	1/2 day	•
26	CxA receives building systems owner training plan, including agendas, attendee lists, and training schedule. Provide 30 days prior to first training.		•		Systems training completed after Cx functional testing completed	-	
27	CxA confirms that Cx issues are resolved. (Preferably all issues are resolved.)		•		CM receives responses addressing and closing out Cx issues	14 days	
28	Cx Report		•		Cx systems testing completed	21 days	
29	Cx Systems Manual		•		Cx systems O & M Manuals sent to CxA	14 days	
30	Cx Warranty Review		•		10 months from date of owner's occupancy	1 day	•

SCHEDULE NOTES:

The following sequential priorities are required to be followed:

1. Equipment is not “temporarily” started (for heating or cooling), until pre-start checklist items and all manufacturer’s pre-start procedures are completed, dirt, dust and other environmental and building integrity issues have been addressed.
2. Functional performance testing does not begin until Pre-Functional, start-up and TAB is completed for a given system.
3. The controls systems and equipment under its control is not functionally tested until all points have been calibrated and Pre-Functional Checklists are completed.

END OF SECTION

SECTION 024100 - GENERAL DEMOLITION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of buildings and site improvements.
2. Demolition and removal of selected portions of building or structure.
3. Removing below-grade construction.
4. Disconnecting, capping or sealing, and removing site utilities.
5. Protection of existing conditions.

B. Related Requirements:

1. Section 013516 "Alteration Project Procedures" for description of Work governing the demolition Work of this Section.
2. Section 015639 "Temporary Tree and Plant Protection" for site protection requirements during demolition and construction.
3. Section 015000 "Temporary Facilities" for temporary construction aids, equipment, site access, barriers, and other requirements for use of Site during demolition and construction.
4. Section 017419 "Construction Waste Management and Disposal" for requirements for demolition waste disposal and recycling.
5. Section 018113.5 "Sustainable Design Requirements - LEED v4 BD+C" for requirements to achieve LEED certification.
6. Section 018113.71 "CALGreen Non-Residential Mandatory Measures" for CALGreen environmental requirements relative to sitework.
7. Section 311000 "Site Preparation and Demolition" for site clearing and removal of above- and below-grade site improvements not part of building demolition.
8. Section 312000 "Earthwork and Grading" for additional information affecting site preparation and demolition.

1.2 DEFINITIONS

- A. General: Definitions included in Section 013516 "Alteration Project Procedures" apply to the Work of this Section.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.4 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site subsequent to Preliminary Conference for Alterations Work specified in Section 013516 "Alteration Project Procedures."
1. Inspect and discuss condition of construction to be demolished.
 2. Inspect and discuss condition of construction to be selectively demolished.
 3. Review structural load limitations of existing structures.
 4. Review and finalize building and site demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 5. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 6. Review procedures for noise control and dust control.
 7. Review and finalize procedures for protection of adjacent buildings, existing trees and vegetation to remain, paths of access and egress to and from adjacent buildings. Review areas where existing construction is to remain and requires protection.
 8. Review items to be salvaged and returned to Owner, if any.

9. Review items to be removed and reused, if any.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building to be demolished and adjacent buildings receiving selective demolition.
- C. Proposed Protection Measures: Refer to Section 013516 "Alteration Project Procedures."
- D. Demolition Schedules: Submit granular detailed schedules of dates and durations of the following demolition activities.
1. Schedule of Building Demolition Activities: Indicate the following:
 - a. Detailed sequence of demolition work, with starting and ending dates for each activity.
 - b. Temporary interruption of utility services.
 - c. Shutoff and capping or re-routing of utility services.
 2. Schedule of Site and Selective Demolition Activities: Indicate the following:
 - a. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure District's building manager's and other tenants' on-site operations are uninterrupted.
 - b. Interruption of utility services. Indicate how long utility services will be interrupted.
 - c. Coordination for shutoff, capping, and continuation of utility services.
 - d. Use of elevator and stairs.
 - e. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
 3. Add high-level general dates and durations to Alteration Work Schedule required by Section 013516 "Alteration Project Procedures."
- E. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before the Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.6 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.
- D. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

1.7 FIELD CONDITIONS

- A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
- B. Architect and District assumes no responsibility for buildings and structures to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by District as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and District. Hazardous materials will be removed by District under a separate contract.
- E. On-site storage or sale of removed items or materials is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 COORDINATION

- A. Arrange demolition schedule so as not to interfere with District's on-site operations or operations of adjacent occupied buildings.

1.9 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

1.10 STORAGE AND HANDLING OF SALVAGED MATERIALS

- A. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by Architect, items may be dismantled and taken to a suitable, protected storage location during construction work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.
- B. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
 1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
 2. Secure stored materials to protect from theft.
 3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 deg F (3 deg C) or more above the dew point

PART 2 - .PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

2.2 SOIL MATERIALS

- A. Satisfactory Soils: Comply with requirements in Section 312000 "Earthwork and Grading."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction provided by District. District does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations. Comply with Section 013233 "Photographic Documentation."
- E. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- F. Inventory and record the condition of items to be removed and salvaged, if any.
- G. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.
- H. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

3.2 PREPARATION

- A. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
- B. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished. Refer to information below and as noted on Drawings.
- C. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities."
- D. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities."
- E. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of demolition.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Utilities to be Disconnected: Locate, identify, disconnect, and seal or cap off utilities serving buildings and structures to be demolished. Refer to Section 311000 "Site Preparation and Demolition" for additional requirements for site demolition and clearing.
1. Arrange to shut off utilities with utility companies.
 2. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
 3. Cut off pipe and conduit to depth below grade as indicated. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
 4. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.4 PROTECTION

- A. Existing Facilities: Protect existing vegetation, walkways, loading areas, building entries, equipment, utilities, and other improvements and facilities at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities. Maintain exits from existing buildings.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of demolition.
- D. Existing Utilities to Remain: Maintain utility services to remain and protect from damage during demolition operations.
1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by District and authorities having jurisdiction.
 2. Provide temporary services during interruptions to existing utilities, as acceptable to District and authorities having jurisdiction.

- a. Provide at least 72 hours notice to occupants of affected buildings if shutdown of service is required during changeover.
- E. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities."
1. Protect adjacent buildings and facilities from damage due to demolition activities.
 2. Protect existing site improvements, appurtenances, and landscaping to remain.
 3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
 4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
 6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
 7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
- F. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- G. Temporary Erosion and Sedimentation Control:
1. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
 - a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - b. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - c. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - d. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- H. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- I. Tree and Plant Protection:
1. Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
 2. Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- J. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 2. Remove snow and ice as required to minimize accumulations.

- K. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- L. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
- M. Maintenance: Maintain protection measures in good operating condition until removal.
 - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- N. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- O. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.5 DEMOLITION, GENERAL

- A. General: Demolish indicated buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 - 2. Maintain fire watch during and for at least two (2) hours after flame cutting operations.
 - 3. Maintain adequate ventilation when using cutting torches.
 - 4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.
- C. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from District and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
 - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- D. Explosives: Use of explosives is not permitted.

3.6 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

3.7 DEMOLITION BY MECHANICAL MEANS

- A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
- B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
- C. Below-Grade Construction: Demolish foundation walls and other below-grade construction.
 1. Remove below-grade construction, including basements, foundation walls, and footings, completely.
- D. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures. Cap existing utilities at edge of Project site.
 1. Piping: Disconnect piping at unions, flanges, valves, or fittings.
 2. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.
- E. Elevator Systems: Demolish and remove elevator system, including pit, cylinder, plunger, well assembly, steel well casing and liner, oil supply lines, and tanks as occurs.

3.8 DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

- C. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.
- D. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.
 - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
 - 2. Remove existing roofing system down to substrate.

3.9 SITE RESTORATION

- A. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Section 312000 "Earthwork and Grading."
- B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.10 REPAIRS

- A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.11 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction. Comply with Section 017419 "Construction Waste Management and Disposal."
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Transport demolished materials off District's property and legally dispose of them.
- B. Do not burn demolished materials.

3.12 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
 - 1. Clean roadways of debris caused by debris transport.

END OF SECTION

SECTION 031000 - CONCRETE FORMING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Formwork for cast-in-place concrete and shotcrete.
 - 2. Installation of cast-in anchors, sleeves and similar items furnished under other Sections.
- B. Related Sections include the following:
 - 1. Section 033000 – Cast-in-Place Concrete.
 - 2. Section 033300 – Architectural Concrete for additional requirements for formwork for cast-in-place architectural concrete.
 - 3. Section 053100 – Steel Decking for leave-in-place formwork for deck-slabs.
 - 4. Formwork for site concrete, including paving, curbs, and steps and walls is furnished under Division 32, "Exterior Improvements," Sections.

1.3 REFERENCES

- A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.
- B. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where designated in this Section. Use applicable year of adoption or revision as published in ACI 301.
- C. American Concrete Institute's:
 - 1. ACI 117 – Specifications for Tolerance for Concrete Construction, 2010.
 - 2. ACI 301 – Specifications for Structural Concrete for Buildings, 2020.
- D. Product Standards:
 - 1. PS1 – Construction and Industrial Plywood.

1.4 DEFINITIONS

- A. Shoring: A System of vertical or inclined supports for forms; may be wood or metal posts, scaffold-type frames or various patented members.
- B. Backshoring: Shores placed snugly under a stripped concrete slab or structural member after the original formwork and shores have been removed from a small area without allowing the slab to deflect or support its own weight or existing construction loads from above.
- C. Reshoring: Shores placed snugly under a stripped concrete slab or structural member after original formwork and shores have been removed from a large area, thus requiring the new slab or member to deflect and support its own weight and existing construction loads prior to the installation of reshores.

1.5 SUBMITTALS

- A. Submittal procedures and administrative provisions are established by Division 01 Section "Submittal Procedures".
- B. Product data for:
 - 1. Formwork. Include all formwork elements and products, including but not limited to form work facing materials and ties.
 - 2. Form release agent used with each type of form facing material.
 - 3. Formwork layout drawings and calculations.
 - a. Show location and detail of formwork ties, construction and control joints not indicated on Contract Documents. Indicate waterstops where occur.
 - b. Show support and tie details.
- C. Shoring, formwork removal and reshoring plan: For suspended slab construction, submit proposed plan for shoring, formwork removal, backshoring, and reshoring, including methods of shoring and sequence and methods of backshoring and reshoring. Include calculations stamped and signed by an engineer licensed in the State of California demonstrating the adequacy of the shoring, backshoring, and reshoring.
- D. Samples: Only as requested by Owner's Representative.

1.6 QUALITY ASSURANCE

- A. Referenced Standard: Comply with provisions of ACI 301, except where more stringent requirements are shown or specified in this Section.
- B. Mockups: Provide formwork as necessary for mockups and test panels.

PART 2 – PRODUCTS

2.1 FORM MATERIALS

- A. General: Comply with ACI 301, Section 2.
- B. Plywood Form-facing Material: PS1, exterior-type plywood manufactured for concrete forming; edge sealed. Acceptable products: Type B-B Plyform, MDOConcrete Form or HDOConcrete Form.
 - 1. Provide only HDOConcrete Form where surface finish SF-3.0 is specified, except as approved by Owners Representative.
 - 2. Mill coating shall be per form release agents specified in this article.
- C. Forms for Cylindrical Columns: Metal, plastic or spiral wound fiber tubes.
- D. Chamfer and Rustication Strips: Softwood strips or PVC, fabricated to produce uniform smooth lines. Strips shall not be ripped from plywood or other engineered wood products. At exposed conditions, provide in longest lengths practical.
- E. Form Release Agents: Commercial formulation compounds, that will not bond with or stain concrete surfaces and will not impair bonding of paint or other coatings intended for use. Compliant with maximum allowable VOC emissions of state and local governing authorities.
 - 1. Use water-based compounds specifically formulated for use on overlay plywood, fiberglass or steel where surfaces remain exposed to view in completed construction.
 - 2. Acceptable products, use for form material noted by manufacturer:
 - a. Duogard II by W.R. Meadows.
 - b. Bio-Nox by Nox-Crete.

- c. Nox-Crete Form Coating E by Nox-Crete.
 - d. Nox -Crete Form Coating EB by Nox-Crete.
 - e. Approved equal.
- F. Form Ties: Snap-off metal ties of fixed length with plastic cone, designed to prevent spalling of concrete upon removal. Provide units that will leave no metal within 1-inch of concrete surface, except as otherwise designated.
- 1. Factory-fabricated, tapered removable ties for forming, will be acceptable at Contractor's option.
- G. Leave-in-place Stakes: Leave-in-place solid PVC or HDPE stakes, intended to serve as a permanent plug in vapor barrier, as necessary for screed stakes and to support formwork for slab on ground construction over vapor retarder. VaporStake™ by VaporStake, LLC or approved equal.
- H. EPS Foam for Forming: Provide load-bearing foam, except as otherwise designated or approved by Owner's Representative.
- 1. Load-Bearing: ASTM C578, Type XIV (40 psi) expanded polystyrene foam (EPS) or extruded polystyrene foam (EPSX) with equal compressive strength and stiffness. Acceptable products: Insulfoam XIV by Insulfoam or approved equal.
 - 2. Void Form: ASTM C578; Type IX (25 psi) expanded polystyrene foam (EPS). Material is intended for use where foam serves only as void form for concrete placement and is not required for support of load in completed work. Acceptable products: Insulfoam IX by Insulfoam or approved equal.
- I. Leave-in-place Carton Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete.
- J. Leave-in-place Ribbed Expanded Metal Forms: Expanded mesh between solid Vribs, ASTM A525 galvanized steel. Same as Stay-Form by Amico or approved equal.
- K. Expansion Joint Filler:
- 1. Fiber-Type: Preformed asphalt impregnated fiber, ASTM D1751, 3/8 inch thick where not otherwise designated.
 - 2. Foam-Type: Closed cell foam. ASTM D5249, Type 2, and ASTM D1752, Sections 5.1 to 5.4 at 10% minimum to 25% maximum compression, 3/8 inch thick where not otherwise designated. Ceramar by W.R. Meadows or approved equal.
- L. Expansion Joint Sealant: Conform to Division 07 Section "Joint Sealants". Sealant used at floors shall be traffic grade, except where joint abuts a wall, column or other vertical surface.

PART 3 – EXECUTION

3.1 CONSTRUCTION OF FORMWORK

- A. Provide, erect, support, brace and maintain formwork and shoring to safely support loads caused by concrete placement and other loads that might be applied, until such loads can be supported by hardened concrete in the completed structure.
- 1. Contractor is responsible for design and engineering of formwork, including shoring, backshoring, and reshoring.
- B. Construct forms to sizes, shapes, lines and dimensions shown and to obtain accurate alignment, level and plumb work in finished structure. Finished work shall conform to tolerances of ACI 117, including tolerances of offsets at panel edges specified below.
- 1. Surface tolerance for finish SF-1.0 is Class D.
 - 2. Surface tolerance for finish SF-2.0 is Class B, unless otherwise indicated.
 - 3. Surface tolerance for finish SF-2.0 is Class C, where SF-2.0 finish surface is not exposed to view in completed construction (pits, surfaces to receive waterproofing, etc.).

4. Surface tolerance for finish SF-3.0 is Class A.
- C. Select form facing materials to obtain required finishes. Solidly butt and back joints to prevent leakage of cement paste.
 1. Provide plywood form-facing for finish SF-2.0, except as otherwise approved by Owners Representative.
 2. Provide HDO overlay plywood form-facing for finish SF-3.0, except as otherwise approved by Owners Representative.
- D. Refer to Specification Section 033000 Table 2 "Finishes for Formed Surfaces" for formed surface finish.
- E. Provide shores and struts with positive means of vertical adjustment. Adjust forms to line prior to concrete placement and only as necessary during concrete placement; do not make adjustments following initial set of concrete.
 1. To maintain specified elevation tolerances, camber formwork to compensate for anticipated deflections during concrete placement, including deflection of lower level floors that support shoring.
- F. Make provisions in formwork for removal of debris from formed spaces. Locate temporary openings in inconspicuous locations at bottom of forms. Close ports with tight fitting panels, flush with inside face of forms.
- G. Chamfer external corners of beams, columns and walls. Provide 3/4-inch chamfer where not otherwise designated.
- H. Plywood Forms at Exposed-to-view Surfaces:
 1. Keep number of panel joints to practical minimum.
 2. Ensure vertical joints are plumb and horizontal joints are level.
 3. Align form ties vertically and horizontally.
- I. Form Release Agent: Apply a coating of form release agent immediately prior to installation of reinforcing steel and embedded items. Do not allow release agent to puddle on forms or concrete.
- J. Provision for Other Trades: Provide openings in formwork and sleeves to accommodate work of other trades. Determine size and location of openings and recesses from trades requiring them. Obtain approval of Owner's Representative for openings not shown on structural drawings.
- K. Earth Forms: Footing forms may be omitted and foundation concrete may be placed directly into neatly and accurately cut excavations, provided the excavation walls are stable.
 1. Earth forms are constructed under Division 31 Section "Structural Excavation and Fill".
 2. Form footings to minimum extent shown on Drawings, but not less than 6 inches below finish grade at surfaces exposed to view. Leave-in place formwork shall not be acceptable in this zone.
- L. Leave-in-Place Formwork: Provide only as designated on Drawings, except as approved by Owner's Representative.
- M. Slab on Grade over Vapor Retarder: Avoid use of stakes through vapor retarder. Stakes will not be permitted where vapor barrier cannot be repaired after removal of stake.
 1. Plastic stakes specifically designed for leave-in-place use by vapor retarder manufacturer will be permitted.

3.2 JOINTS

- A. Expansion Joints:
 1. Provide expansion joints and isolation joints where designated on Contract Documents.

2. Place joint filler in straight line with edge held back to specified dimension from finish surface and secured to formwork or previously placed construction.
3. Use fiber filler at building exterior, except where joints are to be sealed.
4. Use foam type joint filler at all interior joints and at sealed joints at building exterior. Hold edge back as required for sealant application in accordance with sealant manufacturer's recommendations.

B. Construction Joints:

1. Provide where shown on drawings or as approved by the Owner's Representative.
2. Provide 1½ inch deep key indentations at formed joints in beams, walls, and slabs that are 8 inches or more in thickness. Make key 1/3 of member thickness at widest portion of kerfed form.
 - a. Roughen joint to ¼ inch amplitude to expose firmly embedded aggregate prior to second concrete placement.
3. At Leave-in-place Ribbed Expanded Metal Forms, clean leakage, laitance, and all other material from form face to expose clean metal prior to second concrete placement.
4. Provide rustication strips at exposed to view surfaces. Where no reveal remains in completed construction, install ¾ inch x 1-1/2 inch kerfed strip centered on joint and remove strip prior to making second pour.

3.3 EMBEDDED ITEMS

- A. Accurately place and securely support anchorage devices and other embedded items required for other work that is attached to cast in place concrete.
1. Use setting templates, drawings, and instructions provided by supplier of items.
 2. Temporarily fill voids with readily removable material to prevent entry of concrete.
 3. Use only stainless steel fasteners for securing built in items to formwork, where end of fastener is exposed to view or weather in completed construction. Cut back and grind fasteners flush with concrete surface.
- B. Anchor rods (bolts) for steel columns shall be set to tolerances of Section 7.5.1 of AISC "Code of Standard Practice" (2010), which are more stringent than the requirements of ACI 117.
- C. Aluminum Items: Aluminum surfaces in contact with concrete shall be painted with a bituminous paint complying with SSPC Paint 12, "Cold Applied Asphaltic Mastic", 1/8-inch minimum thickness; or other approved coating system.

3.4 FORM REMOVAL

- A. Do not remove forms and shores until concrete has hardened and attained sufficient strength to permit safe removal and adequate support of inherent and imposed loads.
1. In multi-story buildings, provide reshoring, as necessary, to distribute weight of newly placed concrete and construction live loads over sufficient number of floors below. Sequence form removal, shoring and reshoring in accordance with submitted formwork removal and reshoring plan.
 2. Remove top forms on sloping concrete surfaces as soon as removal will not allow concrete to sag.
 3. Loosen formwork for wall openings as soon as loosening operations will not damage concrete.
- B. Carefully remove form facing material to avoid spalling concrete surfaces, in particular at corners and edges of exposed to view concrete. Prying against the face of concrete shall not be allowed.
- C. Where form facing material is removed in less than 3 days, immediately commence curing in accordance with provisions of Section 033000, "Cast-in-Place Concrete".
- D. Beams and One-way Slabs: Maintain forms and shores at underside until concrete achieves 75% of design strength, minimum 7 days. Maintain shores or backshores until concrete has achieved design strength, 21 days minimum. Install reshores, as necessary, where placement continues above.

- E. Two-way Slabs: Conform to submitted formwork removal and reshoring plan.
 - 1. Maintain forms and shores until concrete achieves 75% of design strength, minimum 7 days.
 - a. Form facing material and horizontal supports may be removed after 3 days where formwork system allows shores to remain in place undisturbed by removal of formwork.
 - 2. Maintain shores until concrete achieves design strength, minimum 21 days.
 - a. Shores may be removed after concrete achieves 75% of design strength, minimum 7 days, when replaced by a system of preshores and backshores that prevent slab deflection.
 - b. Maintain backshores until concrete achieves design compressive strength, 21 days minimum.
 - c. For post-tensioned slab construction, shores may be removed following tensioning operation.
 - 3. Where placement continues at additional levels above, provide a system of reshores. One level of shoring or backshoring and minimum 2 additional levels of reshoring shall be maintained until concrete achieves design strength, 21 days minimum.
 - a. For post-tensioned slab construction, reshoring may be removed following tensioning operation of upper most slab.

- F. Post-tensioned Concrete: Maintain forms and shores until post-tensioning operation is completed.
 - 1. Where placement continues at additional levels above, provide reshores. One level of shoring and minimum 2 additional levels of reshoring shall be maintained until post-tensioning operation is complete.

3.5 REUSE OF FORMS

- A. Reuse of forms shall be acceptable provided they are straight, clean, free from nails, dirt, hardened concrete, rust, and other injurious matter and edges and surfaces are in good condition. Reuse of formwork that would reduce quality of exposed-to-view concrete shall not be permitted.

END OF SECTION

SECTION 032000 - CONCRETE REINFORCEMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes:
1. Reinforcement for cast-in-place concrete and shotcrete.
 2. Accessories as required to support and secure reinforcement.
 3. Stud-rails for slab reinforcement.
- B. Related Sections:
1. Section 036100 – Grouted Dowels for installation of reinforcing bar dowels in hardened concrete.
 2. Section 051200 – Structural Steel Framing for reinforcement welded to structural steel.

1.3 REFERENCES

- A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.
- B. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where designated in this Section. Use applicable year of adoption or revision as published in ACI 318, Section 3.2, "Referenced standards", and as noted in this paragraph.
1. ASTM A82 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 2. ASTM A970 – Standard Specification for Headed Steel Bars for Concrete Reinforcement
- C. American Concrete Institute's:
1. ACI 301 – Specifications for Structural Concrete for Buildings, 2020.
 2. ACI 315 – Details and Detailing of Concrete Reinforcing, 2018
 3. ACI 318 – Building Code Requirements for Structural Concrete, 2019.
- D. American Welding Society:
1. AWS D1.4 – Structural Welding Code - Reinforcing Steel, 2018.
- E. Buy Clean California Act Environmental Product Declaration (EPD) Compliance Guide.
1. By the California Department of General Services, latest edition.
<https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act>
- F. CBC – 2022 California Building Code including amendments applicable to DSA regulated facilities.
- G. CGBC – 2022 California Green Building Code
- H. Concrete Reinforcing Steel Institute's:
1. CRSI Manual – "Manual of Standard Practice", 29th Edition.

- I. IAPMO Evaluation Service (IAPMO-ES):
 - 1. IAPMO-ES "Evaluation Reports" and "Acceptance Criteria" indicating compliance of proprietary products for conformance with 2021 International Building Code.
- J. ICC Evaluation Service (ICC-ES):
 - 1. ICCES "Evaluation Reports" and "Acceptance Criteria" indicating compliance of proprietary products for conformance with 2021 International Building Code.
- K. International Standards Organization (ISO)

1.4 DEFINITIONS

- A. Awarding Authority: The state authority under which a California state project is awarded. The University of California shall serve as the awarding authority for non-California state projects
- B. Product Category Rule: The set of rules, requirements, and guidelines accepted by the awarding authority used to develop on EPD for a product group.
- C. Environmental Product Declaration (EPD): A document that reports a product's global warming potential and that:
 - 1. Is developed according to the guidelines of the applicable Product Category Rule acceptable to the California State awarding authority. Reference Buy Clean California Act.
 - 2. Is independently verified in accordance with ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations – Principles and procedures
- D. Manufacturer: An entity that produces the basic construction material that typically requires additional processing by a fabricator before use in a project.
 - 1. A steel mill that produces steel reinforcement is a manufacturer.
 - 2. A facility that bends, welds, cuts, or otherwise shapes reinforcement into shapes is a fabricator.
- E. Global Warming Potential (GWP): A measure of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, and perfluorocarbons produced when manufacturing a product represented by an equivalent amount of CO₂, expressed as CO₂ eq.
- F. Product Category Rule (PCR): The set of rules, requirements and guidelines used to develop an EPD for a product group.

1.5 SUBMITTALS

- A. Submittal procedures and administrative provisions are established by Division 01 Section "Submittal Procedures".
- B. Test Reports: Furnish test reports, evidencing and certifying compliance with specified standards, to Testing Laboratory for record purposes.
 - 1. Reinforcing steel.
 - 2. Shear studs and stud-rail assemblies.
 - 3. Headed deformed bar.
- C. Product data for proprietary items, including bar couplers, headed bars, stud-rails, and welding electrodes.
 - 1. Furnish manufacturer's written installation instructions and Evaluation Reports indicating quality control and special inspection requirements to Testing Laboratory for their use.
- D. Welding Qualifications:
 - 1. Welding procedure specifications (WPS) and procedure qualification records (PQR).

2. Submit welder qualifications to Testing Laboratory for record purposes.
- E. Shop Drawings: Submit placing drawings prepared in accordance with ACI 315. Show size, shape and location of bars in structure. Show splice locations and lengths. Where details are not shown on Contract Documents, conform to standards of practice indicated in ACI 315.
- F. Environmental Product Declarations (EPDs) for all steel reinforcing.
 1. Provide manufacturer's single-facility EPD or company-wide EPD that reports for each facility location supplying material.
 - a. EPD must be valid at the time of material installation.
 - b. The following EPDs are not acceptable:
 - 1) Industrywide and/or industry-average product declarations.
 - 2) Fabricator's product declarations.
 - 3) Companywide declarations that do not report the GWP of its manufacturing facilities separately.
 2. Include at a minimum:
 - a. Product description
 - b. Product category rule under which the EPD was developed.
 - c. Body verifying that the EPD was developed according to ISO 14025 for the applicable PCR.
 - d. Expiration date
 - e. Manufacturer and manufacturer's location
 - f. Global warming potential measured in CO₂ eq.
 3. EPD must be valid at the time of material installation.

1.6 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of ACI 301 and CRSI's "Manual of Standard Practice", except where more stringent requirements are shown or specified.
- B. Material Quality Assurance:
 1. Reinforcing: Mill test reports including chemical analysis, tensile properties and bend test shall be examined for all reinforcing. Conform to one of the following:
 - a. Maintain positive identification of reinforcing by heat number. Provide certified mill test reports to Testing Laboratory.
 - b. Evidence that fabricator's quality assurance procedures ensure that certified mill test reports for each heat have been reviewed for compliance with requirements specified. Evidence shall be satisfactory to Testing Laboratory.
 - c. Where positive identification cannot be made and procedures are not deemed adequate to ensure compliance, Owner's Testing Laboratory will randomly sample and make one tensile and one bend test from each 2½ tons or fraction thereof of each size of reinforcement. Contractor will bear the cost of testing.
 2. Headed Deformed Bars:
 - a. Conform to quality assurance requirements of applicable ICC-ES or IAPMO-ES Evaluation Report.
 - b. Test in accordance with ASTM A970 for each bar size used in the work. Testing may be conducted by manufacturer's laboratory, subject to approval of Owner's Representative. Fabricator shall bear the cost of testing.
 - c. When number of headed bars of one size exceeds 200, tension test 1 additional specimen for each additional 200 heads or fraction thereof.

3. Mechanical Bar Couplers:
 - a. Conform to quality assurance requirements of applicable ICC-ES or IAPMO-ES Evaluation Report.
- C. Qualifications for Welding Work: Qualify welding procedures and welders in accordance with AWS D1.4.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store reinforcement in a manner that will prevent excessive rusting or fouling with grease, oil, dirt, and other bond weakening materials.
- B. Store in a manner to maintain identification of bars after bundles are broken.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Reinforcement, headed bar reinforcement, and dowels shall meet the GWP limits included in Table 1 of the Buy Clean California Act Environmental Product Declaration (EPD) Compliance Guide, and of CGBC Table 5.409.3.
- B. Bar Reinforcement: ASTM A615, Grade 60, or ASTM A706 deformed bars, except as otherwise designated.
 1. ASTM A706 for bars to be welded.
 2. ASTM A706, Grade 60, where designated A706 without designating grade on Contract Documents.
 3. ASTM A706, Grade 80, where designated on Contract Documents.
- C. Headed Bar Reinforcement: Deformed bar reinforcement (#11 and smaller) with forged, welded, or mechanically attached heads conforming to the requirements of ASTM A970, including Annex A1 Requirements for Class HA Head Dimensions. Acceptable systems shall have an active ICC-ES or IAPMO-ES Evaluation Report evidencing compliance with specified criteria and establishing quality assurance and special inspection requirements. Subject to compliance with requirements, provide one of the following, or approved equal:

HRC 555 Headed Bar, by Headed Reinforcement Corp. (ICC ESR-2935).
Bartech Mechanical Anchor, by Dextra Manufacturing Co. (ICC ESR-2166).
Lenton Terminator D16 (taper threaded); by Erico (IAPMO ESR-0129).
- D. Welded Wire Fabric: ASTM A1064.
- E. Smooth Dowels: ASTM A615, Grade 40 or 60, smooth; sawcut or grind ends to remove offsets; shop paint with iron-oxide zinc-chromate primer with 2.0 mils dry film thickness or provide epoxy coated.
- F. Galvanized Reinforcing Bars: ASTM A767 hot-dip galvanized deformed bar reinforcement.
- G. Bar Couplers: Capable of producing Type 1 or Type 2 mechanical splice in accordance with Section 21.1.6 of ACI 318. Select coupler type considering conditions of installation and space limitations; maintain specified cover and reinforcement position acceptable to Owner's Representative. Acceptable coupler systems shall have an active ICC-ES or IAPMO-ES Evaluation Report evidencing compliance with the specified criteria and establishing quality assurance and special inspection requirements.
 1. Couplers may only be used on Grade 60 ($f_y = 60\text{KSI}$) reinforcement.
 2. Type 1 splices shall be acceptable, unless otherwise designated.
 3. Where spliced bars are designated to conform to ASTM A706 or where splices are designated as Type 2 on drawings, splices shall conform to Type 2.

4. Subject to compliance with requirements, provide one of the following mechanical splice systems:

Lenton, Erico Inc. (IAPMO ESR-0129)
Bartec, Dextra America, Inc. (ICC ESR-1705)
Taperlock, Dayton Superior (ICC ESR-2481)
HRC 500/510, Headed Reinforcement Corp (ICC ESR-2764)
Bar-Lock, Dayton Superior (ICC ESR-2495)
GripTwist, Bar Splice Products, Inc (IAPMO ER7960)

- H. Stud-rails: Welded assemblies of specialty headed shear studs and base rails conforming to ASTM A1044. Acceptable stud-rail systems shall have an active ICCES or IAPMOES Evaluation Report evidencing compliance with the specified criteria and establishing quality assurance and special inspection requirements.
- I. Welding Electrodes: AWS D1.4.
- J. Bar Supports: Conform to requirements of CRSI Manual.
1. Provide precast concrete supports, with base not less than 3 inches square, against ground or atop vapor retarder.
 2. Provide CRSI Class 1 plastic or plastic protected supports at surfaces exposed to view or weather in completed construction. Select support type to provide minimum surface contact.
 3. CRSI Class 2 wire supports and precast concrete supports shall be acceptable at surfaces not exposed to view in completed construction.
 4. CRSI Class 3 wire supports shall be acceptable where support is no closer than 1/2 inch to surface or where support is placed atop steel deck.
 5. Supports and tie wire for epoxy coated bars shall be plastic or polymer coated, and shall be of configuration approved by Owner's Representative.

2.2 FABRICATION

- A. Shop fabricate reinforcement to standard fabrication tolerances indicated in ACI 315.
- B. Column Bar Splices: Offset bend bars at 1:6 slope at splices, except at round columns that permit bars to be in the same circle.
- C. Spirals:
1. End Anchorage: Provide 1½ extra turns with 90-degree tie hook at each end of spiral unit.
 2. Splices: Provide designated lap splice and 90-deg tie hook at end of each spiral unit; no additional turns are required. Lap splice shall be minimum 48 bar diameters for deformed bars and 72 wire diameters for smooth wire.
- D. Headed Bars: Headed deformed bars will be allowed to be substituted for 90 deg hooked bars, subject to meeting the requirements specified herein and written approval of Owner's Representative.
1. Bars are designated to be ASTM A615, Grade 60 or ASTM A706, Grade 60.
 - a. Headed bars may be Grade 80 where ICC or IAPMO engineering reports permit their use for Grade 80 reinforcement.
 2. Clearance between headed bars shall be at least 4 bar diameters in accordance with ACI 318, Section 12.6.
 3. A minimum cover of 2 bar diameters, 1½ inches minimum, shall be provided to all faces of head.
 4. Headed bars shall not be substituted for stirrups and ties that serve to confine beam, coupling beam, and column reinforcing.
 5. Contractor shall pay the cost of any additional testing and inspection associated with use of headed bars at no additional cost to the Owner.
- E. Cage Preassembly: Pre-assembled of beam cages by machine fusion welding of holding wires to stirrups shall be acceptable, subject to the requirements below. Welding of holding wires to ties at columns and boundary elements for shear walls shall not be permitted.

1. Stirrup bars shall conform to ASTM A706.
2. Holding wires shall conform to ASTM A82 or A496.
3. Welding shall be performed by machine under a continuous controlled process.
4. Quality control tests shall be performed on fusion-welded specimens at no cost to Owner. Welding shall be performed using the same machines and processes as will be used for in-place reinforcement. A minimum of 3 specimens shall be sampled from the work of the project and tension tested. Tests will be acceptable if the specified minimum tension strength and the required elongation for ASTM A615, Grade 60 reinforcement is achieved. Sampling and testing shall be performed or witnessed by the Owner's Testing Laboratory.

2.3 SOURCE QUALITY CONTROL

- A. Inspection and testing will be performed in accordance with procedures and administrative requirements of Division 01 Section "Quality Requirements".
- B. Testing Laboratory will:
 1. Review Quality Assurance procedures for maintaining identification of steel.
 2. Make one tensile and one bend test from each 10 tons or fraction thereof of each size of reinforcing steel in accordance with CBC Section 1910A.2.
 3. Review Quality Assurance procedures for fabrication of proprietary items, including headed bars, couplers, stud-rails. Perform special inspection as required by applicable Evaluation Report.
 4. Review equipment and Quality Assurance procedures for cage pre-assembly using welded holding wires. Perform or witness specified sampling and testing.

PART 3 – EXECUTION

3.1 PLACEMENT

- A. Place and maintain bars at locations shown on Drawings to the tolerances of ACI 117, including but not limited to the following:
 1. Clear distance to formed surfaces: Plus or minus 1/4 inch.
 2. Top bars in slabs 8 inches deep or less: Plus or minus 1/4 inch.
 3. Top bars in foundations, beams and slabs over 8 inches deep: Plus 1/2 inch and minus 1/2 inch.
- B. Maintain minimum coverage as indicated for concrete protection. Conform to requirements of ACI 301 where not indicated.
 1. Cover shall not be reduced at mechanical couplers and headed reinforcing.
- C. Place reinforcement with 1½ bar diameters minimum clear distance between bars, but not less than 1½ inches. Where specified clearance cannot be achieved, bundle bars.
 1. Conform to additional requirements for spacing of headed bars.
- D. Support and securely fasten bars with chairs, spacers and ties to prevent displacement by construction loads or placement of concrete beyond the tolerances specified. Conform to CRSI "Manual" as a minimum standard.
- E. Take precautions to protect vapor retarder beneath slab-on-ground from damage during installation of reinforcement.
- F. Lap Splices:
 1. Contact Splice: Lapped bars shall be placed in contact and securely tied. Lap shall be oriented to maintain bars in their designated layer, except where offset bent bars are used at splices. Stagger lap splices where necessary to maintain minimum 1 bar diameter and 1 inch clearance between bars at splice.

2. Noncontact Splice: Lapped bars shall be spaced apart a minimum of 1 bar diameter and 1 inch to permit the encasement of the entire surface of the bar in concrete. Bars shall not be spaced farther apart than one-fifth of the lap length and 6 inches maximum. Whenever practical, use noncontact splices, with 4 inch minimum clear spacing, for shotcrete construction.
 - a. Use only noncontact lap splices at shotcrete construction.
 3. Stagger splices of bundled bars so that splices do not overlap.
 4. Welded Wire Fabric: Overlap outermost cross wires of each piece one wire space plus 2 inches. Wire or clip together at maximum 3foot spacing. Stagger splices in one direction.
- G. Mechanical Splices: Make splices in accordance with applicable Evaluation Report. Maintain specified concrete cover at couplers. Stagger mechanical splices as necessary to maintain clearances.
- H. Welding:
1. Welding is not permitted unless specifically detailed on plans or approved by Owner's Representative.
 2. Conform to requirements of AWS D1.4 using qualified procedures.
 3. Welding shall not be done within two bar diameters of any bent portion of a bar which has been bent cold.
 4. Do not tack weld crossing bars for assembly of reinforcement, supports, or embedded items.
- I. Smooth Dowels: Install at locations shown and accurately positioned at right angles to joint being doweled. Dowels shall be rigidly supported during concrete placement and one end of dowel shall be coated with bond breaker.
- J. Reinforcement shall be free of mud, oil or other materials that may reduce bond at the time concrete is placed. Reinforcement with tightly adhered rust or mill scale will be accepted without cleaning; remove loose rust.
- K. Field Straightening: Bar reinforcement shall not be field bent after being embedded in hardened concrete. Reinforcement that is accidentally bent, up to a 1:2 bend (30 deg) and not severely kinked, will be permitted to be straightened subject to the approval of the Owner's Representative. #7 and smaller bars may be straightened cold. Larger bars shall be preheated prior to bending in accordance with the provisions of ACI 301.
- L. Epoxy-Coated Bar Reinforcement:
1. Carefully handle and install bars to minimize job site patching. Use plastic or epoxy-coated bar supports to protect coating from physical damage during placement.
 2. Do not place epoxy-coated bars in contact with uncoated metal surfaces.
 3. Protect coating from damage.
 4. Use coated bar tie wire. Do not cut coating on bars
 5. Wrap exposed reinforcing dowels to protect coating from abrasion and weather damage.
 6. Epoxy coated reinforcement shall not be field bent except as noted on Drawings.
 7. It is not expected that coated bars, when in final position, ready for concrete placement will be completely free of damaged areas. However, numerous nicks and scrapes which expose bare steel will not be allowed regardless of the state when they occur subsequent to the coating in plant. Refer to Section 3.2 for patching of minor coating damage.

3.2 FIELD QUALITY CONTROL

- A. Inspection and testing will be performed in accordance with procedures and administrative requirements of Division 01 Section "Quality Requirements".
- B. Testing Laboratory will:
1. Special Inspect placement of reinforcement for conformance with the Contract Documents, as required by CBC Table 1705A.3. Exceptions 1 through 4 noted in CBC Section 1705.3 do not pply.

2. Special Inspect installation of mechanical couplers in accordance with requirements of applicable Evaluation Report.
3. Special Inspect welding as required by CBC Table 1705A.3.1 and AWS D1.4, for compliance with AWS D1.4; including checking materials, equipment, procedure and welder qualification as well as the welds. Inspector will use nondestructive testing or any other aid to visual inspection that he deems necessary to assure the adequacy of the weld.
4. Observe the straightening of bent reinforcing. Where warranted by severity of bend, Inspector will pull test reinforcing to specified yield strength after straightening.

END OF SECTION

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 1. Refer to Section 018113 for LEED requirements related to this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Cast-in-place concrete, unless otherwise noted.
 - 2. Granular base and underslab vapor retarder assembly beneath building slab-on-ground.
 - 3. Preparation of existing concrete surfaces to receive new concrete.
 - 4. Construction joint waterstops.
 - 5. Grout for baseplates and bearing plates.
- B. Related Sections:
 - 1. Section 018113 – Sustainable Design Requirements.
 - 2. Section 031000 – Concrete Forming.
 - 3. Section 032000 – Concrete Reinforcing.
 - 4. Section 032500 – Post-tension Concrete.
 - 5. Section 033300 – Architectural Concrete: For additional requirements to achieve acceptable visual quality for Architectural Concrete elements.
 - 6. Section 033500 – Concrete Finishing: For finishing and curing of floor surfaces that do not receive a floor covering.
 - 7. Section 033700 – Shotcrete.
 - 8. Division 07 Section – Vapor Emission and Alkalinity Control for New Concrete, for curing compound for floor surfaces to receive glue-adhered floor finishes.
 - 9. Division 09 Section – Resilient Sheet Flooring: For finishing, curing, and treatment of floors surfaces to receive glue-adhered floor finishes.
 - 10. Division 31 Sections for concrete for earthwork and pile foundations.
 - 11. Division 32 Sections for concrete for paving and site work.

1.3 REFERENCES

- A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.
- B. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where designated in this Section. Use applicable year of adoption or revision as published in ACI 301.
- C. ACI: Standards of the American Concrete Institute (ACI) apply where designated in this section. Use applicable year of adoption or revision as published in ACI 301.
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings, 2020.
 - 2. ACI 318 - Building Code Requirements for Structural Concrete, 2019.
- D. CBC – 2022 California Building Code, including provisions applicable to DSA regulated facilities.
- E. CGBC – 2022 California Green Building Code.
- F. IAPMO Evaluation Service (IAPMO-ES):

1. IAPMO-ES "Evaluation Reports" and "Acceptance Criteria" indicating compliance of proprietary products for conformance with 2021 International Building Code.
- G. ICC Evaluation Service (ICC-ES):
 1. ICC-ES "Evaluation Reports" and "Acceptance Criteria" indicating compliance of proprietary products for conformance with 2021 International Building Code.
- H. International Standards Organization (ISO)
- I. State of California, Department of Transportation (Caltrans):
 1. Caltrans Standard Specifications, 2022.
 2. California Test Methods (Available at www.dot.ca.gov/hq/esc/ctms/index.html).
- J. USGBC – LEED v4 Guidelines

1.4 DEFINITIONS

- A. Shrinkage Controlled Concrete: Concrete with shrinkage less than 0.040% when tested in accordance with ASTM C157 (SEAONC modified).
- B. Supplementary Cementitious Material (SCM). Materials included in concrete mix in addition to or as a replacement for cement, and that contribute to concrete properties through hydraulic and/or pozzolanic reactions. Fly ash, ground granulated blast furnace slag, silica fume, and natural pozzolans.
- C. SCM: Supplementary Cementitious Material. Fly ash, ground granulated blast furnace slag, silica fume, metakaolin.
- D. Awarding Authority: The state authority under which a California state project is awarded. The University of California shall serve as the awarding authority for non-California state projects
- E. Product Category Rule: The set of rules, requirements, and guidelines accepted by the awarding authority used to develop an EPD for a product group.
- F. Environmental Product Declaration (EPD): A document that reports a product's global warming potential and that is independently verified in accordance with ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations – Principles and procedures,
- G. Manufacturer: An entity that produces the basic construction material that typically requires additional processing by a fabricator before use in a project.
 1. A concrete ready-mix plant is a manufacturer.
- H. Global Warming Potential (GWP): A measure of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, and perfluorocarbons produced when manufacturing a product represented by an equivalent amount of CO₂, expressed as CO₂ eq.
- I. Product Category Rule (PCR): The set of rules, requirements and guidelines used to develop an EPD for a product group

1.5 SUBMITTALS

- A. Submittal procedures and administrative provisions are established by Division 01 Section, "Submittal Procedures".
- B. Mix design for each concrete mixture, including:
 1. Mixture proportions.

- a. Note method of adjusting mix proportions to account for variation in unit weight of lightweight aggregates.
2. Mixture properties.
 - a. Include compressive strength, slump, entrained air, and fresh density.
 - b. For lightweight concrete, include equilibrium density (ASTM C567 quick method).
- C. Laboratory test reports for concrete mixes.
 1. Compression test data (field experience method) or results of testing (trial batch method) used to establish proportions for each mix.
 - a. Submit sufficient data to represent the range of materials intended for use in the work, in accordance with ACI 318, Section 26.4.4.
 2. Alkali-silica reactivity test data where results of aggregate testing are other than innocuous.
 3. Shrinkage test data or results of testing used to establish mix proportions for shrinkage-controlled concrete.
- D. Material certificates of compliance with specified standards.
 1. Portland cement.
 2. Supplementary cementitious materials, including fly ash and slag cement.
 3. Aggregates, including gradation.
- E. Product data for proprietary materials and items, including admixtures, synthetic fiber reinforcement, bonding agents, finish materials, curing materials, vapor retarder, waterstops, and nonshrink grout.
- F. LEED Submittals: Report information necessary for LEED Certification. Refer to Section 018113 for requirements.
 1. Product Data for Credit MR 5.1: For each material, including its source, cost, and the fraction by weight that is considered regional and that has been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
 2. Product Data for Credit EQ 4.1: Product data and material safety data sheets (MSDS) for installation adhesives, paints, coatings applied on-site on the interior of the building and products used on the interior of the building including printed statement of chemical composition and VOC content of each product used.
- G. Submit ticket to Owner's Testing Laboratory for each batch of concrete delivered, bearing the following information.
 1. Mix identification.
 2. Date and time of batching.
 3. Types and weights of cementitious materials. Sources, sizes and weights of coarse and fine aggregates. Weight of water added at plant. Types and volume of liquid admixtures added at plant.
 4. Volume of water and liquid admixtures added subsequent to initial batching. Time and place of addition.
- H. Products and methods used to strip curing compounds from floors to which other concrete, mortar or plaster is bonded, and evidence of their successful use in similar applications.
- I. Samples as requested by Testing Laboratory or Owner's Representative.
- J. Environmental Product Declarations (EPDs) for all steel reinforcing.
 1. Provide manufacturer's single-facility EPD or company-wide EPD that reports for each facility location supplying material.
 - a. EPD must be valid at the time of material installation.
 - b. The following EPDs are not acceptable:

- 1) Industrywide and/or industry-average product declarations.
 - 2) Fabricator's product declarations.
 - 3) Companywide declarations that do not report the GWP of its manufacturing facilities separately.
2. Include at a minimum:
- a. Product description
 - b. Product category rule under which the EPD was developed.
 - c. Body verifying that the EPD was developed according to ISO 14025 for the applicable PCR.
 - d. Expiration date
 - e. Manufacturer and manufacturer's location
 - f. Global warming potential measured in CO₂ eq.
 - 1) EPD must be valid at the time of material installation
3. EPD must be valid at the time of material installation.

1.6 QUALITY ASSURANCE

- A. Comply with applicable provisions of following codes and specifications, except where more stringent requirements are shown or specified.
1. ACI 301: Specifications for Structural Concrete for Buildings.
 2. ACI 318: Building Code Requirements for Reinforced Concrete.
- B. Concrete batch plant shall comply with the requirements of ASTM C94, Section 10, as certified by the National Ready Mixed Concrete Association.
- C. Concrete Supplier's Testing Laboratory shall comply with the requirements of ASTM E329 and be under the direction of a professional engineer, licensed in the State of California.
- D. If the test results of aggregates for potential reactivity (ASTM C289) are other than innocuous, concrete mixtures shall be tested in accordance with ASTM C1567. Tests shall indicate an expansion of less than 0.10 percent at 16 days age.
- E. Preconstruction Conference: Contractor shall convene a preconstruction conference at the job site a minimum of two weeks prior to placing concrete slab-on-grade. Attendees shall include at a minimum; General Contractors superintendent and foreman, the concrete sub-contractor, a representative from the flooring sub-contractor, a representative from the concrete batch plant, the Special Inspector, a representative from the Testing Laboratory, the architect, and the structural engineer. Inform attendees a minimum of seven days prior to convening meeting. Attendance via web or phone conference is acceptable. Purpose of meeting is to:
1. Review slab-on-grade flatness and levelness requirements.
 2. Review formed and placed elevated slab flatness and levelness requirements.
 3. Review concrete fill on steel deck slab flatness requirements.
 4. Review schedule for making flatness and levelness measurements.
 5. Formed and placed elevated slabs must be measured prior to removing shoring.
 6. All concrete should be measured as soon after placement as practical.
 7. Review anticipated maximum steel beam wet dead load deflection, contractor's placement, leveling, and finishing methods, and anticipated average and maximum additional fill due to beam and deck deflection.
 8. Review formed and placed elevated concrete fill on steel deck slab concrete mix design for acceptability for receiving adhesive for flooring and/or carpets and/or overlays intended as preparation for receiving adhesive for flooring and/or carpeting.
 9. Review formed and placed elevated slab concrete fill on steel deck finish requirements and contractor's proposed methods for meeting slab finish requirements for:
 - a. Floors receiving adhesive for flooring and/or carpets, and/or
 - b. Overlays intended as preparation for receiving adhesives for flooring and/or carpeting.

PART 2 – PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cementitious materials and aggregates shall have a proven history of successful use together, or submit evidence satisfactory to Owner's Representative that aggregate will not react harmfully in presence of alkalis in cement.
- B. Cementitious materials and aggregates for concrete for exposed surfaces of like elements shall be from same source throughout the work.
- C. Cementitious Materials: Combination of Portland cement and supplementary cementitious materials; subject to limitations specified herein.
1. Portland cement: ASTM C150, Type I, II or V, low alkali.
 2. Fly ash: ASTM C618, Class C or Class F; except the maximum loss on ignition shall not exceed 1.0%.
 3. Slag cement, same as ground granulated blast furnace slag: ASTM C989, Grade 100 or 120.
 4. Silica Fume: ASTM C1240.
 5. Metakaolin: ASTM C618.
- D. Coarse Aggregates:
1. ASTM C33.
 2. Cleanness value shall not be less than 75 when tested in accordance with California Test 227, "Evaluating Cleanness of Coarse Aggregate".
 3. Aggregate shall contain no thin or elongated pieces. The length of any piece shall not exceed 2½ times the average thickness.
 4. Aggregate for Shrinkage Controlled Concrete shall be from one of the following sources, or approved equal: Orca (as supplied by Cemex or Hanson), Sechelt (as supplied by Hanson), limestone (Hanson), granite (Granite Rock's Aromas), or Clayton (as supplied by Hanson or Cemex).
 5. Aggregate for Lightweight Concrete: ASTM C330, rotary kiln-expanded shale or clay having surface sealed by firing. 3/8 inch size. As manufactured by Trinity Expanded Concrete & Shale, Utelite Corporation, or approved equal.
- E. Fine Aggregates:
1. ASTM C33.
 2. Sand equivalent shall not be less than 75 when tested in accordance with California Test 217, "Sand Equivalent".
- F. Water: Combined water consisting of potable water and reclaimed water from mixer wash-out operations; subject to limitations specified herein.
1. Provide 100% potable water for Architectural Concrete, Shrinkage Controlled Concrete, post-tensioned concrete, and lightweight concrete.
 2. Combined water for other uses may contain maximum 25% reclaimed water meeting requirements of ASTM C1602.
- G. Admixtures: Where mix contains more than one admixture, all admixtures shall be supplied by one manufacturer. Manufacturer shall certify that admixtures are compatible such that desirable effects of each admixture will be realized. Acceptable Manufacturers: BASF Construction Chemicals, W.R. Grace and Co., or Euclid Chemical Co.
1. General: Admixtures containing more than 0.05% chloride ions are not permitted.
 2. Air-entraining: ASTM C260. Where entrained air is not specified in Contract Documents, total air shall not exceed 3% by volume.
 3. Water-reducing: ASTM C494, Type A.
 4. Set-retarding: ASTM C494, Type B or Type D. Provide in necessary dosage to achieve desired set time.

5. Set-accelerating: ASTM C494, Type C, non-chloride. Provide in necessary dosage to achieve desired set time.
 6. Mid-range Water-reducing: ASTM C494, Type A/F, polycarboxylate formulation designed to minimize shrinkage. Provide in manufacturer's recommended (mid-range) dosage where specified, or where otherwise requested by Contractor to increase slump to facilitate pumping and/ or placement.
 7. High-range Water-reducing (superplasticizer): ASTM C494, Type F, polycarboxylate formulation designed to minimize segregation and shrinkage. Where specified, provide in manufacturer's recommended (high-range) dosage.
 8. Viscosity-modifying (VMA): ASTM C494, Type S. Provide in manufacturer's recommended dosage to facilitate pumping, subject to approval of Owner's Representative.
 9. Shrinkage-reducing (SRA): ASTM C494, Type S. Acceptable products: Eclipse® Floor 200 by W.R. Grace, MasterLife® SRA 035 by MasterBuilders, or approved equal.
 - a. Provide at one and one-half gallons per cubic yard of fresh concrete. Dosage may be adjusted at recommendation of concrete batch plant with architect's approval.
 - b. Where floor is intended to be ground and polished, verify compatibility of admixture with hardener.
- H. Micro-synthetic Fibers: Synthetic fibers, manufactured from 100 percent virgin homopolymer polypropylene resins, designed for use as secondary reinforcing to reduce plastic shrinkage in concrete. Shall conform to ASTM C1116 for Type III fiber reinforced concrete and the requirements of ICC-ES AC32, Section 3.1.1 (plastic shrinkage reinforcement). Acceptable products: MasterFiber™ M100 by BASF, Fibermesh® 300 by Propex, Grace Fibers™ by W.R. Grace, or approved equal.
1. Incorporate at a dosage rate as recommended by manufacturer.
- I. Macro-synthetic Fibers: Synthetic fibers, manufactured from polypropylene/polyethelene resins, designed for use as shrinkage and temperature reinforcing for concrete. Shall conform to ASTM C1116 for Type III fiber reinforced concrete and the requirements of ICC-ES AC32, Sections 3.1.1 (plastic shrinkage reinforcement) and 3.1.2 (shrinkage and temperature reinforcing). Acceptable products: MasterFiber™ MAC 100 by BASF, Novomesh® 950 by Propex, STRUX® 90/40 by W.R. Grace, or approved equal.
1. Unless otherwise indicated, incorporate at a dosage rate of 2.0 pounds per cubic yard.

2.2 RELATED MATERIALS

- A. Granular Base: Broken stone or crushed or uncrushed gravel, angular, free of deleterious matter, silt, clay, and/or organic matter. Gradation conforming to the following: 100% passing the 3/4-inch sieve, less than 10% passing the No. 4 sieve, and less than 2% passing the No. 200 sieve.
- B. Underslab Vapor Retarder: ASTM E1745, Class A plastic sheeting, complying with Section 033053.03 "Miscellaneous Concrete Accessories."
- C. Waterstop: Hydrophilic strip waterstop designed to stop water infiltration through cast-in-place concrete construction. Compound shall expand to seal and fill voids in construction joints to prevent water infiltration under continuous immersion and wet/dry cycling.
1. Typical: 1-1/4" x 1/2" trapezoidal strip reinforced with a poly scrim. Use at construction joints in concrete sections thicker than 8 inches with two layers of reinforcing steel. Acceptable products: Waterstop RX 101T by CETCO, Swellstop No. 594 by Sika, or approved equal.
 2. Thin Section: 3/4" x 3/8" half circle. Use at construction joints in concrete sections less than 8 inches thick or with a single layer of reinforcing steel. Acceptable products: Waterstop RX 102 by CETCO, Swellstop No. 596 by Sika, or approved equal.
 3. Adhesive: As recommended by waterstop manufacturer. Acceptable products: CETSEAL by CETCO, Swellstop primer adhesive by Sika, or approved equal.
- D. Evaporation Reducer: Monomolecular film-forming compound to prevent rapid drying of fresh concrete. Subject to compliance with requirements provide one of the following, or equal.

Eucobar, by Euclid Chemical, Co.
MasterKure ER 50, by BASF Corp.

- E. Moisture-retaining Cover (for curing):
1. Fabric: Cellulose or polypropylene fabric adhered to an unperforated, opaque impervious coating providing UV protection, non-staining; conforming to ASTM C171. Acceptable Products: UltraCure NCFä by Sika Corporation, Transguard 4000® by Reef Industries, Inc., or equal.
- F. Curing Compounds:
1. Type CC-1: Dissipating resin curing compound conforming to ASTM C309, Type 1, Class B, with a VOC less than 100 g/L. Acceptable products: 1100- by WR Meadows, Kurez DR-100 by Euclid Chemical Co., or approved equal
 2. Type CC-2: ASTM C1315, Type 1, Class A, curing and sealing compound. Minimum 30% solids, waterbased-, non-yellowing acrylic copolymer, with a VOC less than 100g/L. Acceptable products: Dayton Superior Cure & Seal 1315 EF (no known equal), or approved equal.
 3. Type CC-3: Water-based, reactive penetrant specifically formulated for concrete curing. Shall meet or exceed the water retention requirements of ASTM C1315 (0.40 kg/m² in 72 hours). Shall leave no surface residue and be compatible with patching compounds, paints and other wall coatings. Acceptable products: Sinak WCEä, by Sinak (no known equal).
 4. Type CC-4: Compound for vapor emission control that also serves as a curing compound. Shall meet or exceed the water retention requirements of ASTM C309 (0.55 kg/m² in 72 hours). Refer to Division 07 Section Vapor Emission and Alkalinity Control for New Concrete” for requirements and acceptable products.
- G. Floor Leveling Compound: High strength, Portland cement-based, nonshrink, self-leveling product designed specifically for leveling of concrete floors to receive adhered floor coverings. Compound shall install in thickness from featheredge to 1 inch in a single application. Minimum 4,000 psi compressive strength. Acceptable products: Ardex K 15® Self Leveling Underlayment Concrete, Mapei Ultraplan 1 Plus by Mapei International, Uzin NC 150 by Uzin Utz North America, or approved equal.
1. Primer: Product of underlayment manufacturer recommended for substrate conditions.
 2. Aggregate: Where thickness exceeds 1-inch, add well-graded, washed aggregate, of gradation and amount as recommended by underlayment manufacturer.
- H. Nonshrink Grout: Premixed, nonmetallic, noncorrosive product, conforming to ASTM C1107. Minimum usable working time of 30 minutes at flowable consistency over temperature range of 50 deg F to 85 deg F. Acceptable products: Masterflow^o 555 by BASF, Five Star® Grout by Five Star Products, Inc., N.S. Grout by Euclid Chemical Company, or approved equal.

2.3 MIXES

- A. Concrete mixes shall meet the GWP limits included in CGBC Table 5.409.3. Weighted averages for all concrete mixes used in the project calculated in accordance with CGBC Exception Equation 5.409.3.1 may be used
- B. All concrete normal weight except where noted in drawings or other articles this specification.
- C. Lean Concrete: Not used. Refer to Section 312300, "Structural Excavation and Fill", for controlled low strength material (CLSM).
- D. Mix "A": High SCM mix for foundation elements including spread footings, grade beams, elevator pits, and sump pits.
1. Compressive strength: 4,000 psi at 56 days. (ASTM C39).
 2. Slump: 5 inches, plus or minus 1inch tolerance (ASTM C143).
 3. Cementitious material: One of the following blends, measured by weight:
 - a. 50% Portland cement and 50% fly ash; or
 - b. 40 to 50% Portland cement, 30 to 40% slag, and 15 to 20% fly ash.
 - c. Where fly ash is not commercially available, 50% to 60% Portland cement, 40% to 50% slag.

4. Aggregate: Size 57 (1 inch) or Size 67 (3/4-inch) coarse aggregate blended with pea gravel to achieve a well graded blend.
- E. Mix "A-EC": Alternate mix for foundation elements including spread footings, grade beams, elevator pits, and sump pits.
1. Compressive strength: 4,000 psi at 28 days. (ASTM C39).
 2. Slump: 6 inches, plus or minus 1-inch tolerance (ASTM C143).
 3. Cementitious material: Shall include a minimum of 25% fly ash or slag, or combination of the two, measured by weight.
 4. Aggregate: Size 57 (1-inch) or Size 67 (3/4-inch) coarse aggregate (3/4-inch) blended with pea gravel to achieve a well graded blend.
- F. Mix "B": For slab-on-ground, normal-weight fill over steel deck, curbs and equipment pads, stair pan fills.
1. Compressive strength: 4,000 psi at 28 days (ASTM C39).
 2. Slump: 6 inches, plus or minus 1-inch tolerance (ASTM C143).
 3. Cementitious material: Total cementitious material shall not be less than 550 lbs per cubic yard.
 - a. Contractor may include up to a total of 20% fly ash, ground granulated blast furnace slag, or a combination of the two, at their option. Contractor shall consult with concrete finishing sub-contractor to confirm the quantity of fly ash and ground granulated blast furnace slag included in the concrete mix.
 4. Aggregate: Size 57 (1-inch) coarse aggregate.
 - a. Coarse aggregate shall be from specified source for Shrinkage Controlled Concrete. Do not blend pea gravel with shrinkage controlled aggregates.
 5. Admixtures: Mid-range, water-reducing admixture at necessary dosage to provide adequate slump and workability at specified water content.
 6. Limit total water to minimum required for complete cementitious material hydration, anticipated at between 275 lbs per cubic yard and 285 lbs per cubic yard maximum.
 7. Limit water-to-cementitious material ratio to 0.45 by weight.
- G. Concrete required to satisfy CGBC Material Conservation and Resource Efficiency.
1. Concrete mix shall include supplementary cementitious materials and shall be proportioned to satisfy the following equation:
 - a. $F/25 + SL/50 + UF/12 > 1.0$, where F = class F fly ash, SL = ground granulated blast furnace slag or class C fly ash, and UF = silica fume or metakaolin.
- H. Patching Mortar: One part Portland cement to two parts sand. At exposed surfaces, substitute white cement as necessary to match color of surrounding concrete.
1. Intended for use for patching of form ties and bug holes. Not suitable for repairing large defects; provide pre-packaged repair mortar suitable for size, shape, and location (horizontal, vertical, or overhead surface) of defect and approved by Owner's Representative.

2.4 PROPORTIONING

- A. Contractor shall determine the mix proportions for concrete in conformance with these specifications.
- B. Proportion mixes in accordance with ACI 301, on the basis of field experience or trial batches.
1. When trial batch method is used, trial batches shall be proportioned by Contractor's Design Laboratory that conforms to specified quality assurance requirements.
 2. Conform to additional requirements of ACI 211.2 for lightweight concrete.
- C. Proposed mixes shall produce concrete to strengths specified with adequate workability and proper consistency to permit concrete to be conveyed by pumping and worked into forms and around reinforcement without excessive segregation or bleeding.

- D. The total chloride ion content, calculated on the basis of mix proportions, shall not exceed the limits specified in ACI 318 Table 19.3.2.1 when tested per ASTM C1218 at age between 28 and 42 days inclusive. The total chloride ion content shall not be allowed to exceed 0.30% for any use.
- E. Mix design adjustments may be requested by Contractor when job conditions or test results warrant. Revised mix design must be submitted to and accepted by Owner's Representative before using in work.
 - 1. Approved set-accelerating and set-retarding admixtures may be used to control set times when warranted by weather conditions, without resubmittal of mixes.
 - 2. Batching weight of lightweight aggregates shall be adjusted to maintain a constant volume of aggregate, without resubmittal of mixes.

2.5 CONCRETE MEASUREMENTS AND MIXING

- A. Materials for concrete shall be measured by weighing the aggregates and cement using equipment that is suitable, designed and constructed for this purpose. Each size of aggregate and the cement shall be weighed separately. The accuracy of all measuring devices shall be such that quantities be measured to within the following percentages of the desired amount: 1% for cement and water, 2% for aggregates, and 3% for admixtures. Mixing water and all admixtures shall be measured by volume.
- B. All concrete shall be machine mixed in accordance with ACI 318, Section 26.5. Deposit concrete into final position within 90 minutes of introduction of cement.
 - 1. Mixing time shall be reduced in hot weather in accordance with Hot Weather Concreting provisions of this Section.
 - 2. Mixing time shall be increased to accommodate project conditions, only with prior written approval of Owner's Representative and subject to use of set retarders, control of revolutions of mixing drum and monitoring of concrete temperature.
- C. After initial batching, additions shall be limited to water, high range water reducers and non-chloride accelerators, subject to the following:
 - 1. Additions shall be made only in the presence of Testing Laboratory, using suitable calibrated devices.
 - 2. Water additions shall not exceed water-to-cementitious ratio requirements and/or maximum water content requirements.
 - 3. Following addition of HRWR or accelerator admixtures, complete a minimum of 70 revolutions or 5 minutes of mixing to assure a consistent mixture.

2.6 SOURCE QUALITY CONTROL

- A. Inspection and Testing will be performed under provisions of Division 1.
 - 1. Testing Laboratory will review mix designs and certificates of compliance for materials Contractor proposes to use.
- B. Batch Plant Inspection:
 - 1. An approved special inspector from the Owner's Testing Laboratory shall review mix proportions with the licensed weighmaster at the start of each day's placement and observe the first batching.
 - 2. Licensed weighmaster to positively identify materials as to quantity and certify to each load by ticket.
 - 3. Tickets shall be transmitted to the inspector of record by a truck driver with load identified thereon. The inspector will not accept the load without a load ticket identifying the mix and will keep a daily record of placements, identifying each truck, its load and time of receipt and approximate location of deposit in the structure and will transmit a copy of the daily record to the enforcement agency.
 - 4. At the end of the project, weighmaster shall furnish an affidavit to the enforcement agency certifying that concrete furnished conforms in every particular to proportions established by mix designs.

PART 3 – EXECUTION

3.1 GENERAL

- A. Examine units of work to be cast and verify that:
 - 1. Construction of formwork is complete.
 - 2. Required reinforcement, inserts, and embedded items are in place and securely held.
 - 3. Concrete-receiving places are free of debris and excess water.
- B. Protect finished surfaces adjacent to concrete-receiving places.

3.2 CONSTRUCTION JOINT PREPARATION

- A. Horizontal Joints: Remove entire surface to expose clean aggregate solidly embedded in mortar matrix to full 1/4-inch amplitude. Do not leave laitance, loosened particles of aggregate or debris at surface.
 - 1. At Contractor's option, use chemical surface retarder as an aid to joint preparation.
- B. Vertical Joints: Remove formwork and coatings to expose clean and sound concrete. Joints that are formed and keyed in accordance with drawings need not be intentionally roughened.
- C. Waterstops: Provide at construction joints in below grade pits and where indicated on Drawings. Install waterstops in accordance with manufacturer's written instructions, using adhesive. Tightly butt ends of adjoining sections; do not overlap. Protect waterstop from wetting prior to concrete placement; replace waterstop that has partially hydrated.
 - 1. Place typical waterstop with 3 inches minimum cover to concrete surface exposed to water, and between layers of reinforcing.
 - 2. At thin sections, place waterstop with 2 inches minimum cover nearest to face of concrete exposed to water.

3.3 PREPARATION FOR SLAB-ON-GROUND CONSTRUCTION

- A. Place granular base to thickness specified on Drawings. Consolidate and smooth surface with a vibratory plate.
- B. Place underslab vapor retarder under all slabs on grade in accordance with Section 033053.03 "Miscellaneous Concrete Accessories," unless otherwise indicated.

3.4 PLACING

- A. Examine units of work to be cast and verify that:
 - 1. Construction of formwork is complete.
 - 2. Required reinforcement, inserts, and embedded items are in place and securely held.
 - 3. Concrete-receiving places are free of debris and excess water.
- B. Protect finished surfaces adjacent to concrete-receiving places.
- C. Notify Owner's Representative at least 24 hours before placing concrete.
- D. Placing Record: Record time and date of casting concrete in units of building; maintain record open to inspection by the Owner's Representative.
- E. Convey concrete as rapidly and directly as practicable to preserve quality and to prevent segregation.
 - 1. Concrete discharge shall be complete within 90 minutes after the introduction of mixing water to the cement and aggregates or, the introduction of the cement to the aggregates or, 300 revolutions of the mixing drum, whichever comes first.

- a. The 90-minute and 300 revolution limits may be waived when set retarding admixtures are included in the concrete mix and with the architect's approval. Concrete shall have retained sufficient slump at the time of placement to be properly placed and consolidated without the addition of water.
- F. Cold Weather Placement: When concrete is likely to be subjected to freezing temperatures within 24 hours or when placing concrete at air temperatures less than 40 deg F, the temperature of the concrete at the point of placement shall be at least 55 deg F for sections thinner than 12 inches and 50 deg F for sections thicker than 12 inches. Do not exceed this temperature by more than 20 deg F. Use only approved accelerating admixtures.
- G. Hot Weather Placement: When air temperature exceeds 80 deg F, take special precautions to prevent slump loss, rapid setting, and plastic shrinkage; including but not limited to:
 1. Cool ingredients before mixing to maintain concrete temperature at point of placement below 90 deg F.
 2. Cover reinforcing steel with water-soaked burlap, so that steel temperature will not exceed ambient air temperature.
 3. Convey and deposit concrete as rapidly as practicable, such that concrete temperature does not exceed 90 deg F at point of placement.
 4. Apply evaporation reducer immediately after screeding.
- H. Placing Concrete in Forms:
 1. In depositing concrete in columns or walls, place concrete in a manner that will prevent segregation and accumulation of hardened concrete on the forms or metal reinforcement above the level of the concrete.
 - a. Limit concrete free fall to four feet maximum.
 2. Deposit concrete in horizontal layers and in a manner to avoid inclined joints. Place each layer while preceding layer is still plastic to avoid cold joints.
 3. Keep forms and reinforcement clean above pour line.
 4. Do not use vibrators to transport concrete in forms.
- I. Consolidating:
 1. Use internal vibrators for thorough consolidation of all concrete.
 2. Use size and power recommended by ACI 309 for the element of work.
 3. Use consolidation techniques that minimize entrapped air; refer to ACI 309.
 4. Do not place vibrators against reinforcement or forms.
- J. Construction joints shall conform to typical details and be located where shown on Drawings or approved by the Owner's Representative. Horizontal joints in walls and columns shall be at the underside of slabs. Place beams, girders, brackets, column capitals, haunches, and drop panels at the same time as the slabs.
- K. Floor Slabs on Steel Framing:
 1. Deposit concrete working outward from beam centers to avoid overloading steel deck.
 2. Maintain specified concrete thickness over steel deck as a minimum. Increase thickness as required to compensate for deflection of steel deck.

3.5 FINISHING FOR NON-FORMED SURFACES

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces.
- B. Finish Schedule: Refer to Article 3.11, "Finish Schedule" for finish types and locations. Refer to Division 03 Section "Concrete Finishing" for specialty finishes of exposed to view concrete.

- C. Flatness/Levelness Tolerances: Measure floors for flatness (SOF_F) and levelness (SOF_L) according to the method of ASTM E1155, within 72 hours after slab finishing. Floors shall conform to tolerances of ACI 117 listed in Finish Schedule.
1. Exception: Tolerance for levelness does not apply to floors supported by steel framing; measure floor levelness for information only.
 2. Corrective action: Failure to achieve the specified tolerances will require remedial action, including grinding and/or application of leveling materials. The cost of remedial action will be borne by the Contractor.
- D. Slab Finishes:
1. Scratch Finish: Place, consolidate, strike off, and level concrete. Roughen surface with stiff brooms or rakes prior to final set.
 2. Float Finish: Place, consolidate, strike off and level concrete. Do not work further until concrete is ready for floating. Consolidate surface with a bladed power float with float shoes or a powered disk float, or by hand floating if area is small or inaccessible to power driven floats. Repeat float passes until surface conforms to specified tolerances and is left with a uniform, smooth, granular texture.
 3. Trowel Finish: After applying float finish, power-trowel the surface. Continue troweling passes until surface is planed to the specified tolerance and uniform in texture. Do not burnish floors intended to receive floor coverings. Hand trowel the surface smooth and free of trowel marks.
 4. Broom Finish: After applying float finish roughen surface by drawing a fiber bristle broom, not less than 24 inches wide, across surface perpendicular to main traffic route. Produce even texture from edge to edge, lapping adjacent strokes slightly to produce uniform pattern.
 - a. Obtain Owner's Representative's approval for texture of final finish before application.
 5. At lightweight concrete, take measure to prevent creating a densified surface layer.
 - a. Ensure bleed water has evaporated from concrete. Soft-trowel finish, do not hard trowel. Limit trowel passes to minimum possible.

3.6 FINISHES FOR FORMED SURFACES

- A. General: Perform subsequent finishing operations as soon as practical after stripping formwork, except as specifically noted.
- B. Finish Schedule: Refer to Article 3.11, "Finish Schedule" for finish types and locations. Refer to Division 03 Section "Concrete Finishing" for specialty finishes of exposed to view concrete.
- C. Surface Finish – 1.0 (Rough Formed):
1. No formwork facing material is specified.
 2. Patch voids larger than 1½ in. wide or 1/2 in. deep.
 3. Remove projections larger than 1 in.
 4. Tie holes need not be patched.
 5. Surface tolerance Class D as specified in ACI 117.
- D. Surface Finish – 2.0 (Smooth-formed):
1. Plywood formwork facing.
 2. Patch voids larger than 3/4 in. wide or 1/2 in. deep.
 3. Remove projections larger than 1/4 in.
 4. Patch tie holes.
 5. Surface tolerance Class B as specified in ACI 117; except Class C shall be acceptable where finish surface is not exposed (pits, surfaces to receive waterproofing, etc.) subject to leveling abrupt offsets as required to accept application of finish materials or waterproofing.
- E. Surface Finish – 3.0 (As-cast exposed-to-view): Concrete shall have uniform as-cast surface with minimal additional finishing being anticipated or required.
1. Patch voids larger than 3/4 in. wide or 1/2 in. deep, surface blemishes will not be filled.

2. Remove projections larger than 1/8 in. by grinding without marring surface.
 3. Fill tie holes and strike flush with adjacent surfaces, except as otherwise noted.
 4. Surface tolerance Class A as specified in ACI 117.
 5. Mockup of concrete surface appearance and texture required.
- F. Sandblasted Finish: After obtaining as-cast, exposed-to-view surface, light sandblast, sufficient to expose fine aggregate with occasional exposure of coarse aggregate, to produce uniform color and a degree of reveal of approximately 1/16 inch.
- G. Sacked Finish: After stripping formwork, thoroughly wet concrete surface, apply grout to fill surface blemishes. Remove all traces of grout from surface by rubbing with clean burlap. Continue curing.
1. Grout: Combine one part cement to one and one-half parts sand by volume, and a 50:50 mixture of acrylic bonding admixture and water to form the consistency of a thick paint. Blend standard Portland cement and white cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.
- H. At tops of walls and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.

3.7 CURING AND PROTECTION

- A. General: Start initial curing as soon as free water has disappeared from concrete following finishing. Keep concrete continuously moist for 7 days minimum after placement.
1. Subject to approval of Owner's Representative, application of curing compound may be delayed when specialty compound for moisture vapor emission is used for curing, usually 4 to 24 hours. Slab shall be carefully monitored for moisture content at the surface and compound shall be applied prior to evaporation rate exceeding moisture emission rate.
- B. Curing Methods:
1. Curing compound: Apply specified curing compound as soon as final finishing operations are complete. Uniformly apply two coats of compound in a continuous operation with second coat at right angles to first. The total coverage for the two coats shall be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Recoat concrete surfaces subjected to rainfall within 3 hours after the curing compound application. Maintain compound on the concrete surface throughout the curing period and immediately repair any damage.
 - a. Use Type CC-1 compound, unless otherwise designated.
 - b. Use Type CC-2 curing and sealing compound for interior floors that remain exposed to view in completed construction. At Contractor's option, use CC-1 for initial curing; strip and apply CC-2 curing and sealing compound at a later date.
 - c. Use Type CC-3 penetrant-type compound for surfaces to receive paint, fluid applied waterproofing or other coatings.
 - d. Use Type CC-4 compound for floor areas scheduled to receive glue-adhered floor finishes. Refer to Division 07 Section "Vapor Emission and Alkalinity Control for New Concrete" for requirements.
 2. Moisture-retaining cover: As soon as concrete is sufficiently set to permit application without marring surface, unroll cover over the entire area, laid smooth without folds or bunches of material. Lay blanket in accordance with manufacturer's instructions, overlapping edges a minimum of 6 inches and extending ends 12 inches beyond area of concrete to be cured. Immediately repair holes or tears that occur within first 5 days using sheeting material and waterproof tape.
 - a. Curing paper is preferred cover for slabs to receive adhered floor finishes.
 - b. Laminated burlap is preferred cover for concrete with water to cementitious material ratio less than 0.42.

- c. Prewet laminated burlap sheeting as installation progresses.
 - d. Maintain cover in place for 7 days for normal weight concrete; cover may be removed in 5 days for lightweight concrete.
3. Moist curing: Continuous misting, sprinkling or ponding. Intermittent wetting is not acceptable.

SG – Please confirm the curing compounds we should specify as it relates to your finishes.

- C. Limitations: Accomplish curing by one of the specified methods, subject to the following limitations.
1. Moisture-retaining cover curing will be the only acceptable method(s) for floors that are scheduled to receive adhered floor finishes.
 2. Compound curing will only be permitted for surfaces to which other concrete, mortar or plaster is bonded if compound is stripped from concrete surface.
 3. Refer to Division 03 Section "Concrete Finishing" for curing of exposed to view slab surfaces scheduled to receive special floor finish.
- D. Cold Weather Requirements: Protect concrete from freezing during the first 7 days after placement.
- E. Hot Weather Requirements: When hot weather conditions will cause an evaporation rate exceeding 0.2 pounds of water per square foot per hour, as determined by Figure 2.1.5 of ACI 305, cure for initial 24 hours minimum by moisture retaining cover methods.

3.8 SAW CUT JOINTS

- A. Construct contraction joints in slabs-on-grade using saw cuts 1/8 inch wide by one inch deep, unless otherwise indicated.
- B. If joint pattern is not shown, provide joints to create approximately square panels not exceeding 30 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bay, etc.).
- C. Sawcut as soon as concrete will bear the weight of equipment and operator, usually 1 to 4 hours after finishing. Perform sawcut with early-entry dry-cut saw. Ensure that saw does not ride up over hard or large coarse aggregate. Change saw skid plates in accordance with manufacturer's recommendations as required to control raveling and spalling at joint edges.
- D. Perform all cuts cleanly and smoothly to a constant and equal depth in as continuous an operation as possible to avoid misalignment of joints. Use only experienced personnel and forms or templates as required to achieve consistent lines.

3.9 CLEANING, PATCHING AND DEFECTIVE WORK

- A. Cleaning: Remove curing compounds, form release agents and other materials employed in concrete work that prevent proper application of finishes, sealants, waterproofing materials, or other treatments. Use positive method, as recommended by manufacturer, to achieve complete removal.
1. For floors scheduled to receive glue-adhered floor finishes, chemically strip Type CC-1 curing compound 7 days minimum to 14 days maximum following placement.
- B. Repair of Formed Surfaces: Immediately after form removal, cut out honeycombs, rock pockets, and voids. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat surface of void with neat cement paste. Immediately fill and compact with patching mortar.
1. Use patching mortar for form ties and for minor repairs.
 2. Use pre-packaged, shrinkage-compensated structural repair mortar, acceptable to Owner's Representative, for larger repairs.
- C. Repair of Floor Slabs for Flatness and Levelness: Repair floors as necessary to achieve specified finish tolerances and as otherwise required for proper installation of building components.

1. After concrete has cured at least 28 days, correct high areas by grinding.
2. Correct low areas with underlayment installed according to manufacturer's written instructions, including but not limited to priming prepared surfaces, to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

3.10 GROUTING BASEPLATES

- A. Prior to erection, clean and roughen concrete surface beneath baseplate; clean bottom surface of baseplate of bond-reducing materials. After columns have been positioned and plumbed, flow nonshrink grout solidly between bearing surfaces to ensure no voids remain. Comply with manufacturer's recommendations for mixing, placing, finishing and curing of grout.

3.11 FIELD QUALITY CONTROL

- A. Inspection and testing will be performed in accordance with procedures and administrative requirements of Division 01 Section "Quality Requirements".
- B. Testing Laboratory will:
 1. Collect and review tickets for each batch of concrete delivered. Annotate water or admixtures added subsequent to batching.
 2. Special Inspect concrete construction, as required by CBC Table 1705A.3, for conformance with the Contract Documents.
 3. Compressive strength: Sample and test concrete for compressive strength at the frequency prescribed by ACI 318, Section 26.12.2 and CBC Section 1905A.1.15. A sample shall be the average of two 6 by 12 inch cylinders or three 4 by 8 inch cylinders. Cylinders shall be molded and cured in accordance with ASTM C31 and tested in accordance with ASTM C39 at 28 days.
 - a. On first day's placement of each concrete mix, mold two additional cylinders and test at 7 days. 7-day testing is not required thereafter.
 - b. Where design strength is specified at 56 days, perform testing at 56 days. On first day's placement of concrete mix, mold four additional cylinders; test 2 at 7 days and 2 at 28 days. 7-day and 28-day testing is not required thereafter.
 - c. For post-tensioned concrete, mold an additional cylinder for each sample for testing prior to stressing.
 - d. For lightweight concrete, take cylinders at point of placement.
 4. Slump: ASTM C143; one test at start of placement and every two hours thereafter.
 - a. For lightweight concrete, test at truck and point of placement to monitor slump loss.
 5. Temperature: ASTM C1064; one test every two hours during hot weather. Make additional tests when warranted by delays in delivery.
 6. Air content: ASTM C173; one test hourly at point of placement for mixes with more than 3% air.
 7. Wet density: ASTM C138; sample and test lightweight concrete at truck at start of each day's placement. Continue testing until mixes achieve target density.
 8. Equilibrium density: ASTM C567; sample lightweight concrete every 2 hours at point of placement. Oven dry samples and test for dry density in accordance with ASTM C567. Report calculated equilibrium density in accordance with ASTM C567 "quick method", based on oven dry density plus 3 pcf.
 9. Nonshrink grout:
 - a. Inspect mixing and placing of nonshrink grout.
 - b. Test for compressive strength in accordance with ASTM C109. Make one sample for each 2 hours of grout placement.
- C. The Contractor shall pay Testing Laboratory for investigating of low-strength compressive test results in accordance with ACI 318, Section 26.12.4, except where results of test cylinders are not representative of in-place concrete.

3.12 FINISH SCHEDULE

- A. The concrete finish types specified in "Table 1 - Finishes for Non-Formed Surfaces" and "Table 2 - Finishes for Formed Surfaces", which follow, shall be used except as otherwise designated on drawings.
 - 1. Exposed surfaces that are scheduled to receive paint, sealers or other thin finish coatings shall be considered "Exposed-to-View".
 - 2. Exposed-to-view Curbs and Stair Risers: Provide monolithic finish by stripping forms while concrete is green and steel-troweling surfaces to a dense, hard finish with corners intersections and terminations slightly rounded.
- B. Refer to Section 031000, "Concrete Forming", for formwork requirements for exposed-to-view surfaces.
- C. Refer to Division 03 Section "Concrete Finishes" for specialty finishes. In case of conflict, the requirements of "Concrete Finishes" shall take precedence over the requirements herein.

TABLE 1: FINISHES FOR NON-FORMED SURFACES			
Surface	Finish	Tolerances	Curing
Floor to receive carpet	Trowel / do not burnish	Moderately Flat SOF _F = 25 SOF _L = 20	Fabric moisture retaining cover or CC-4
Floor to receive resilient flooring	Trowel / do not burnish	Flat SOF _F = 35 SOF _L = 20	Fabric moisture retaining cover or CC-4
Floor to receive thin-set tile	Trowel Refer to Division 09 for subsequent preparation	Flat SOF _F = 35 SOF _L = 20	Moisture retaining cover or CC-3
Floor to receive epoxy terrazzo	Trowel / do not burnish	Very Flat SOF _F = 45 SOF _L = 25	Moisture retaining cover (paper)
To receive bonded topping or mortar bed	Scratch	---	Moisture retaining cover
Exposed concrete (utility)	Trowel	Conventional SOF _F = 20 SOF _L = 15	CC-2 cure/seal or CC-1 cure removed and sealed with CC-2
Polished concrete floor	Trowel	Very Flat SOF _F = 45 SOF _L = 20	Moisture retaining cover
Parking	Swirl	---	CC-2
Roof	Float	---	CC-1

Note: Tolerance SOF_L does not apply to steel frame floors.

TABLE 2: FINISHES FOR FORMED SURFACES		
Surface	Finish	Notes
Concealed, except as otherwise noted.	SF-1.0	CC-1 curing where required per Concrete Forming
To receive waterproofing or cement plaster	SF-2.0	CC-1 curing where required per Concrete Forming, removed
Pits (inside face)	SF-2.0	CC-1 curing where required per Concrete Forming
Exposed to view, building interior utility areas	SF-2.0	CC-1 curing where required per Concrete Forming
Exposed to view, building interior, public areas	SF-3.0	Refer also to requirements for Architectural Concrete
Exposed to view, building exterior	SF-3.0	Refer also to requirements for Architectural Concrete

END OF SECTION

SECTION 033053.03 - MISCELLANEOUS CONCRETE ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes miscellaneous cast-in-place concrete materials, including the following:
 - 1. Underslab vapor retarder and accessories.
- B. Related Requirements:
 - 1. Division 03 Sections for cast-in-place concrete, formwork and reinforcing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product, including installation and repair instructions.

PART 2 - PRODUCTS

2.1 UNDERSLAB VAPOR RETARDERS

- A. Vapor Retarder: ASTM E1745, Class A plastic sheeting, with a water vapor permeance less than 0.01 perms; minimum 15 mil film thickness, minimum 45 lb/in tensile strength, and minimum 2200 grams puncture resistance.
 - 1. Acceptable products:
 - a. Moistop Ultra 15 by Henry Company (Fortifiber Corporation)
 - b. Stego Wrap 15 mil Class A by Stego Industries.
 - c. Or equal.
 - 2. Provide manufacturer's recommended seam tape, double sided tape, termination tack strips, mastic or liquid flashing, and preformed pipe and penetration boots for sealing of edges, seams, and penetrations.
 - 3. Patch Material: Vapor retarder material of similar or better permeance, puncture resistance, and tensile strength as recommended by vapor retarder manufacturer.
 - 4. Termination Bar: Provide non-corrosive metal termination bar for below-slab vapor retarder with anchors to secure vapor retarder terminations.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Level and compact base material according to ASTM E1643 and civil and structural engineering drawings and specifications.
- B. If a capillary break is required by the geotechnical report or is shown on Drawings, cover with at least 2 inches of fine-grained fill. For granular base course, use a minimum 4-inch layer of compactable granular fill, avoiding concrete sand.
- C. Avoid puncturing vapor retarder. Inspect the vapor retarder for any punctures or damage that could compromise its effectiveness. Repair punctures according to vapor retarder manufacturer's instructions.
- D. Place concrete over vapor retarder as soon as possible.

3.2 UNDERSLAB VAPOR RETARDER INSTALLATION

- A. Sheet Vapor Retarders: Place, protect, and repair vapor retarder according to ASTM E 1643, ASTM F710, ACI 302.2R, manufacturer's written instructions, and applicable recommendations of NRMCA CIP-29. Apply requirements of geotechnical report. Unless otherwise indicated, provide underslab vapor retarders under all concrete slabs on grade.
1. Place underslab vapor retarder with longest dimension parallel with direction of pour, lapping seams 6 inches and sealing with manufacturer's recommended adhesive or pressure sensitive tape.
 2. Clean laps and penetrations where dirt or other debris may impair adhesion of seam tape or mastic.
 3. Seal penetrations (pipes, conduits, columns, utilities) with manufacturer's recommended penetration boot, mastic or liquid flashing, adhesive/sealant, and seam tape.
 4. Seal around penetrations through vapor retarder to create a monolithic membrane between the surface of the slab and the subgrade.
 5. Where vapor retarder is interrupted at interior or edge footings, lap vapor retarder 2 inches minimum over footing.
 6. Avoid driving non-permanent stakes through the retarder and repair penetrations if needed. Use reinforcing bar supports designed to minimize puncturing. If a blotter layer is used, ensure it is dry before concrete placement and protect it from precipitation.
 7. Avoid tearing vapor retarder sheets with rebar reinforcement, dowels, anchors, and other devices and accessories.
- B. Vapor Retarder Termination: At all perimeter terminations, and elsewhere as shown, install per ASTM E 1643, manufacturer written instructions and the following requirements:
1. Lay vapor retarder loosely, to prevent concrete from pulling on termination.
 2. Turn vapor retarder up at foundation walls or forms, and other conditions that may impede installation, such as exposed reinforcement, dowels, waterstops, etc.
 3. Terminate edges of loosely laid vapor retarder at a height elevation consistent with the top of the slab.
 4. Secure vapor retarder in place by anchoring termination bar to vertical surface, with butyl tape between vapor retarder and substrate.
 5. Install expansion anchor in each predrilled hole.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: District will engage a qualified testing and inspecting agency to perform tests and inspections and prepare test reports.
- B. Installation Inspections: Engage underslab vapor retarder manufacturer's technical representative to inspect installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete vapor retarder system and all related accessories are installed without deficiencies. Include review and inspection of materials to ensure correct products have been installed as indicated in approved Submittal.
- C. Do not place concrete until inspection agency has inspected and accepted vapor retarder installation, and damaged areas have been repaired.
- D. Underslab vapor retarder will be considered defective if it does not pass inspections.

3.4 PROTECTION

- A. Limit disturbance of vapor retarder and until concrete is placed. Avoid damaging the vapor retarder during construction. Prevent sharp crushed rock from being in direct contact and use a cushion or blotter layer if necessary.
- B. Be mindful of high foot traffic and extreme conditions. To greatest extent possible, do not allow construction personnel from walking on exposed vapor retarder sheets until concrete is placed.

3.5 REPAIRS

- A. Make repairs to vapor retarder and place slab in accordance with Division 03 Sections and as recommended by vapor retarder manufacturer's instructions.
 - 1. Repair vapor retarder damaged during placement of reinforcement or concrete with patch of vapor retarder material.

- B. Identify and repair any damage before concrete placement. Clean the damaged area. Seal small holes with tape. For larger damage, use a patch overlapping by 6 inches beyond edges of damaged area and seal the perimeter with tape. Ensure continuity with a patch for cut slabs.

END OF SECTION

SECTION 033300 - ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cast-in-place architectural concrete including form facings, reinforcement accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

1.2 DEFINITIONS

- A. Cast-in-Place Architectural Concrete: Formed concrete that is exposed to view on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
- B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
- C. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Cast-in-place architectural concrete subcontractor.
 - 2. Review concrete finishes and finishing, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Formwork Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
- D. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.
- E. Samples: For each of the following materials:
 - 1. Form-facing panel.

2. Form ties.
3. Form liners.
4. Coarse- and fine-aggregate gradations.
5. Chamfers and rustications.

- F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 18 by 18 by 2 inches, of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each of the following:
1. Cementitious materials.
 2. Admixtures.
 3. Form materials and form-release agents.
 4. Repair materials.
- B. Material Test Reports: For the following, by a qualified testing agency:
1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Comply with Division 03 Section "Cast-in-Place Concrete."
- B. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 and Section 6, "Architectural Concrete."
 2. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."
- C. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- D. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches minimum, to demonstrate the expected range of finish, color, and texture variations.
1. Locate panels as indicated or, if not indicated, as directed by Architect.
 2. Demonstrate methods of curing, aggregate exposure, sealers, and coatings, as applicable.
 3. In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
 4. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 5. Demolish and remove field sample panels when directed.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for formwork and other form-facing material requirements.

- B. Form-Facing Panels for As-Cast Finishes: Steel, glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that will provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will provide surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Form Liners: Units of face design, texture, arrangement, and configuration to match design reference sample. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.
- E. Rustication Strips: Metal, rigid plastic, or dressed wood with sides beveled and back kerfed; nonstaining; in longest practicable lengths.
- F. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch, minimum; nonstaining; in longest practicable lengths.
- G. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800, "Specification 810.1, Expanded Cellular Glazing Tape"; minimum 1/4 inch thick.
- H. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS, that adheres to form joint substrates.
- I. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.
- J. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- K. Form Ties: Factory-fabricated, glass-fiber-reinforced plastic, removable ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Provide in the structural design of the forms the location of ties within the joints such that patches of tie holes will be in recessed joints.
 - 2. Furnish ties with tapered tie cone spreaders that, when removed, will leave holes 3/4 inch (19 mm) in diameter on concrete surface.

2.2 STEEL REINFORCEMENT AND ACCESSORIES

- A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI's "Manual of Standard Practice."
 - 1. Where legs of wire bar supports contact forms, use CRSI Class 1, gray, plastic-protected or CRSI Class 2, stainless-steel bar supports.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use cementitious materials and aggregates, of the same type, brand, and source, throughout Project complying with Division 03 Section "Cast-in-Place Concrete."

- B. Water: Potable, complying with ASTM C 94/C 94M except free of wash water from mixer washout operations.

2.4 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
- C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 - 1. Color: As selected by Architect from manufacturer's full range.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
 - 1. For integrally colored concrete, curing compound shall be pigmented type approved by color pigment manufacturer.
 - 2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2.6 REPAIR MATERIALS

- A. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
 - 1. Types I and II, non-load bearing or Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete according to service loadings.

2.7 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
- B. Proportion concrete mixtures as follows:
 - 1. Compressive Strength (28 Days): 3500 psi (24.1 MPa).
 - 2. Maximum Water-Cementitious Materials Ratio: 0.46.
 - 3. Slump Limit: 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
 - 4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.
- C. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
- F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.8 CONCRETE MIXING

- A. Ready-Mixed Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
 1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
 2. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for formwork, embedded items, and shoring and reshoring.
- B. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.
- C. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 1. Class A, 1/8 inch (3.2 mm).
- D. Fabricate forms to result in cast-in-place architectural concrete that complies with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.
 1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
 2. Do not use rust-stained steel form-facing material.
- F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- G. Chamfer exterior corners and edges of cast-in-place architectural concrete where indicated.

- H. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- M. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

3.2 REINFORCEMENT AND INSERTS

- A. General: Comply with Division 03 Section "Cast-in-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.
- B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.3 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Schedule form removal to maintain surface appearance that matches approved field sample panels.
 - 2. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
- B. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.4 JOINTS

- A. Construction Joints: Install construction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
 - 2. Form keyed joints as indicated. Align construction joint within rustications attached to form-facing material.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- B. Contraction Joints: Form weakened-plane contraction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
 4. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.6 FINISHES, GENERAL

- A. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
- B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.

1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

C. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

3.7 AS-CAST FORMED FINISHES

- A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects.
- B. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

3.8 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.
- B. Begin curing cast-in-place architectural concrete immediately after removing forms from concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
 1. Moisture Curing: Keep exposed surfaces of cast-in-place architectural concrete continuously moist for no fewer than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for no fewer than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.
 3. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 FIELD QUALITY CONTROL

- A. General: Comply with field quality-control requirements in Division 03 Section "Cast-in-Place Concrete."

3.10 REPAIRS, PROTECTION, AND CLEANING

- A. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
 1. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Architect's approval.
- B. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
- C. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

- D. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
- E. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.
 - 1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION

SECTION 033546 - CONCRETE FLOOR TREATMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes topically applied concrete floor treatments for exposed concrete finishing in locations indicated on Drawings. Concrete floor treatments include:
 - 1. Penetrating densifier/hardener used for dustproofing, sealing, and hardening concrete surfaces.
- B. Related Requirements:
 - 1. Concrete for sealed concrete, including concrete materials, mixture design, placement procedures, initial finishing, and curing is specified in Section 033000 "Cast-in-Place Concrete."

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review concrete placement and curing procedures, concrete finishing, and protection of sealed concrete before and after sealer application.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For liquid concrete floor treatments to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Verify compatibility of sealer material with concrete curing admixtures prior to concrete placement to ensure compatibility. Provide curing products and concrete admixtures that are compatible with finish coat in locations indicated to receive finish coat.
- B. Provide the following upon request:
 - 1. Qualification Data: For Installer and Testing Agency.
 - 2. Material Certificates: For each of the following, signed by manufacturer:
 - a. Hardener/sealer.

1.6 MOCKUPS

- A. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for materials and execution, including surface finish, typical joint treatment, tolerances, and standard of workmanship.
 - 1. A mockup is, or mockups may be, required to validate performance and appearance related characteristics (including but not limited to color, sheen, inherent surface variations, wear, abrasion resistance, chemical resistance, stain resistance, and slip-resistance), to ensure system performance as specified for the intended use, and to determine application methods and procedures of the finish flooring system..
 - a. Locate mockups in location to be concealed by subsequent flooring materials as directed by Architect.
 - b. Apply full-thickness mockups on minimum 48-inch-square floor area.
 - c. Demonstrate application, curing, finishing, and protecting of sealed concrete.
 - d. Simulate finished lighting conditions for Architect's review of mockups.

2. Engage an authorized testing agency to test mockup for slip-resistance after cure according to ANSI A137.1/A326.3. If values for dynamic coefficient of friction exceed indicated values, provide additional mockups applying manufacturer's recommended remediation procedures. Test each subsequent mockup for slip-resistance until flooring passes test. Do not proceed with application of concrete sealer on remaining portions of the Work until mockups pass testing.
3. After acceptance of test, when directed by Architect, prepare mockup floor area, including possible removal of floor sealer and any residual effects, as required by subsequent flooring manufacturer, and cover mockup area with scheduled flooring as instructed.

1.7 FIELD CONDITIONS

- A. Traffic and Stain Control: For cast-in-place concrete slabs scheduled to receive sealer, protect concrete from foot traffic, construction chemicals, spills, and stains prior to, and during sealer application to ensure uniform quality and look of freshly placed concrete.
- B. Environmental Limitations: Comply with sealer manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting sealer application.
- C. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during sealer application.
- D. Close spaces to traffic during sealer application and for 24 hours after application.

PART 2 - PRODUCTS

2.1 FLOOR TREATMENTS, GENERAL

- A. Source Limitations: Obtain sealer materials, including treatments and finishing products, from a single manufacturer.
- B. Dynamic Coefficient of Friction: Provide sealed concrete installed on walkway surfaces with dynamic coefficient of friction indicated as determined by testing identical products per ANSI A137.1/A326.3 DCOF AcuTest procedure.
 1. Dynamic Coefficient of Friction: Not less than 0.42 dry and 0.5 wet.
- C. VOC Content of Liquid-Applied Floor Coating Components: Not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 FLOOR TREATMENT MATERIALS

- A. Dustproofing Hardener/Sealer: VOC-compliant, lithium-based, penetrating densifier, hardener, dustproofing and concrete sealer.
 1. Products: Subject to compliance with requirements, provide Pentra-Sil (HL) as manufactured by Convergent Concrete Technologies, LLC, or Architect approved equal with the following characteristics:
 - a. No surface filming.
 - b. UV-resistant.
 - c. Impact, wear, and abrasion resistant.
 - d. Chemical and stain resistant.
 - e. VOC Content: <50g/L

PART 3 - EXECUTION

3.1 EXECUTION, GENERAL

- A. Inspect condition of existing concrete to be sealed in the presence of Architect, finishing subcontractor, and sealer material manufacturer's representative. Determine whether repairs are required. If required, follow the preparation and application procedures for repairing material prior to sealing. If repair is not required, skip directly to sealer application procedures below.
- B. During and after curing, protect floors from staining and contamination.

3.2 PREPARATION

- A. Prepare and clean substrates according to concrete treatment manufacturer's written instructions. Concrete hardener/sealer may be applied to newly placed concrete or to existing cured and dry concrete.
- B. Newly Placed Concrete: Finish newly placed concrete and prepare for treatment according to floor treatment manufacturer's instructions.
- C. Existing Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with sealer or that provide a splotchy end product. Clean surface before application to remove any dirt, laitance, curing compounds or coatings that may prevent the floor hardener/sealer from penetrating the surface. Do not use citrus or acidic cleaners. If acidic or d-limonene cleaners have been used, neutralize the surface using an alkaline cleaner (TSP, Tide laundry detergent, etc.) according to manufacturer's instructions..
 - 1. Repair damaged and deteriorated concrete according to sealer manufacturer's written instructions.
 - 2. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
 - 3. If water moisture tests exceed manufacturer's stated limits, remediate according to manufacturer's instructions.
 - 4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- D. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to floor treatment manufacturer's written instructions.
- E. Protect adjacent surfaces during installation and finishing of concrete floor treatment.

3.3 APPLICATION

- A. Apply concrete treatment according to manufacturer's written instructions. Apply according to application methods and procedures as tested and approved in preconstruction mockup.
- B. Using a sprayer, apply concrete hardener/sealer evenly on the surface. Keep the surface wet with product for at least 20 minutes, adding more product where needed.
- C. On newly placed, machine-troweled concrete, apply hardener/sealer immediately after finishing, immediately after joints have been cut and cleaned, or anytime thereafter. As the material dries into the surface, spread out any puddles with a soft bristle broom or a flat microfiber pad.
- D. Allow floor treatment to cure according to manufacturer's written instructions. Prevent contamination during application and curing processes.

- E. Using a stiff broom or auto-scrubber, remove any excess residue that forms on the surface after the product dries.

3.4 PROTECTION

- A. Protect sealed concrete floor from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by concrete treatment manufacturer.
- B. Do not place any protective plastic sheeting, rubber matting, rugs, or furniture that will trap moisture or prevent proper drying, which can result in a cloudy effect on the floor.
- C. Limit pedestrian use until 24 hours after installation. Normal pedestrian use may occur after 7 days.

END OF SECTION

SECTION 036100 - GROUTED DOWELS IN CONCRETE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Reinforcing bar dowels and threaded installed in hardened concrete using adhesive prepackaged in cartridges.
 - 2. Reinforcing bar dowels and threaded rod installed horizontally through hardened concrete using epoxy adhesive placed by injection method.
 - 3. Reinforcing bar dowels and threaded rod installed vertically through hardened concrete with flowable epoxy adhesive.
- B. Related Sections:
 - 1. Section 050525 – Post-Installed Concrete Anchors for installation of adhesive anchors for attachment of nonstructural and structural components.

1.3 REFERENCES

- A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.
- B. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where designated in this Section.
- C. CBC: 2022 California Building Code.
- D. ICC-ES: ICC Evaluation Service:
 - 1. AC308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements, 2022.

1.4 SUBMITTALS

- A. Submittal procedures and administrative provisions are established by Division 01 Section "Submittals".
- B. Product data for proprietary materials, including epoxy adhesives and nonshrink grout. Include manufacturer's detailed instructions for storage and handling, installation, and special inspection.
 - 1. Include current ICC-ES Evaluation Service Report for adhesives prepackaged in cartridges.

1.5 QUALITY ASSURANCE

- A. Cartridge Adhesive: Products proposed for use shall have an ICC-ES Evaluation Service Report evidencing compliance with ICC- ES acceptance criteria AC308 for use to resist tension and shear in cracked and uncracked concrete.
 - 1. Installation shall conform to manufacturer's written instructions listed in ICC ES report.
- B. Low-viscosity Epoxy Adhesive: Prior to the start of production installation, Contractor's on-site supervisor shall conduct a field training session demonstrating materials and methods to be employed in the Work.

Attendance by the following is mandatory: Installer's personnel to be qualified for performance of the work, adhesive manufacturer's representative, and Owner's Testing Agency.

1. Demonstrate installation techniques.
2. Identify quality assurance measures.
3. Present plan for protection of anchors from accidental disturbance during curing period.

PART 2 – PRODUCTS

2.1 ADHESIVE AND GROUT MATERIALS

A. Cartridge Adhesive

1. Epoxy Adhesive: Two-component, 100% solids, structural epoxy conforming to ASTM C881, Type IV; Grade 3; prepackaged in cartridges for manually or pneumatically operated caulk gun and automatically mixed at nozzle. Approved for use in cracked and uncracked concrete in accordance with ICC ES AC308, as demonstrated by a valid ICC-ES Evaluation Service Report. Subject to compliance with specified requirements, provide one of the following, or equal:

SET-3G Epoxy Adhesive, Simpson Strong-Tie Co.
Pure 110+, Dewalt
HIT-RE 500-V3 Adhesive, Hilti Inc.

2. Hybrid Adhesive: Two-component, hybrid adhesive prepackaged in cartridges for manually or pneumatically operated caulk gun and automatically mixed at nozzle. Approved for use in cracked and uncracked concrete in accordance with ICC ES AC308, as demonstrated by an active ICC Evaluation Service Report. Subject to compliance with specified requirements, provide one of the following, or equal:

AT-XP Adhesive, Simpson Strong-Tie Co.
AC200+, DeWalt/Powers
HIT-HY 200-R V3 Adhesive, Hilti Inc.

- #### **B. Low-viscosity Epoxy Adhesive: Two-component, 100 percent solids, high-strength, creep-resistant, liquid epoxy; capable of bonding to damp surfaces. ASTM C881, Type IV, Grade 1, Class C. Minimum heat deflection temperature of 125 degrees F, ASTM D648. Use epoxy adhesive materials to suit the width of annulus to be injected in accordance with manufacturer's recommendations. Subject to compliance with requirements provide one of the following, or equal:**

MasterInject 1500, Sika
MaterInject 1380, Sika

2.2 DOWELS

- #### **A. Reinforcing Bars: ASTM A615, Grade 60, or ASTM A706, deformed. Embedded end shall be free of offsets that interfere with installation.**
- #### **B. Threaded Rod: Refer to Specification Section 050525 "Post-Installed Anchors".**

PART 3 – EXECUTION

3.1 INSTALLATION

- #### **A. General: Employ drilling and hole cleaning methods that comply with OSHA Code of Federal Regulations Standard 1926.1153, Respirable Crystalline Silica, Table 1. Reference: <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.1153> for more information.**

1. Install anchors in conformance with manufacturer's written instructions.

3.2 EXAMINATION

- A. Examine areas to be drilled to verify conditions of access, interferences, and existing materials.
- B. Locate existing reinforcing steel, which might interfere with drilling, with a suitable metal detector, ground penetrating radar, or by chipping.

3.3 PREPARATION

- A. Protect existing exposed surfaces from grouting operations.
- B. Dowels shall be free of oil, mud, loose rust or other materials that may reduce bond.

3.4 INSTALLATION WITH CARTRIDGE ADHESIVE

- A. General:
 - 1. Install anchors in accordance with manufacturer's written instructions, including drilling, hole cleaning, dispensing of epoxy and setting of dowels.
 - 2. All hole orientations may be installed using cartridge adhesive.
- B. Drilling:
 - 1. Drilling Equipment: Use electric or pneumatic rotary type drilling hammer with medium or light impact and carbide tipped masonry bit. Where edge distances are less than 2 inches clear, use lighter impact equipment to prevent microcracking during drilling process.
 - a. Take care to minimize break-out at back of hole at through-dowels. Use light impact equipment or other methods.
- C. At horizontal and vertical through-dowels, overhead applications, and dowel embedment greater than twelve inches, use manufacturer's piston plug system to place grout in hole. Plug back of hole at through-dowels.

3.5 INSTALLATION WITH EPOXY USING INJECTION METHOD

- A. Through-dowels in horizontal and vertical holes shall be installed using epoxy grout injection method.
- B. Drilling:
 - 1. Drilling Equipment: Use electric or pneumatic rotary type drilling hammer with medium impact and carbide tipped masonry bit. Minimize breakout of concrete at back of hole by using light impact or other methods.
 - 2. Hole Diameter: Drill holes to a diameter 1/8 inch larger than the nominal diameter of the dowel.
- C. Cleaning: Clean holes in accordance with manufacturer's recommendations and in compliance with OSHA requirements.
- D. Grouting at horizontal through-dowels:
 - 1. Set dowel in proper position and temporarily secure.
 - 2. After installing through bar, install injection tube beneath bar at one end and install relief tube above bar on opposite end of drilled hole and seal ends.
 - 3. When seals are cured, inject low-viscosity epoxy under pressure through lower tube until flow is received from upper relief tube.
 - 4. Tie off injection and relief tubes to maintain positive head as necessary to prevent leakage of epoxy until epoxy has cured, then remove.

- E. Grouting at vertical through-dowels:
 - 1. Sequence installation to occur before new concrete work.
 - a. Set dowel in proper position and temporarily secure. Plug bottom of hole to permit epoxy injection without leaking out.
 - b. Fill annulus around bar with low viscosity liquid epoxy. Work dowel in a circular motion to ensure complete filling.
 - c. Remove plug from bottom of hole prior to placing new concrete below dowel.

3.6 INSTALLATION WITH NONSHRINK GROUT

- A. Through-dowels in vertical holes may be installed using non-shrink grout method.
- B. Drill holes to a diameter 1-inch minimum larger than the nominal diameter of the dowels.
- C. Drill holes using water-cooled core drilling equipment. Roughen surface by method acceptable to Owner's Representative.
- D. Clean hole by flushing with water hose inserted to back of hole until water runs clear, brush twice with round steel wire bristle brush of appropriate diameter, and flush with hose until water runs clear.
- E. Place reinforcing bar into hole. Provide centralizing devices as required to maintain bar at center of core.
- F. Mix and place grout at fluid consistency in accordance with manufacturer's recommendations. Do not add more water than recommended by manufacturer.
- G. Cure by covering with wet cloth for 3 days minimum or by coating with curing compound.

3.7 ABANDONED HOLES

- A. Fill abandoned vertical holes with nonshrink grout. Fill abandoned horizontal holes with epoxy grout.

3.8 CLEANING

- A. Clean excess epoxy from around holes before it hardens only on surfaces that will not be exposed to view.
- B. On surfaces that will be exposed to view, allow epoxy to cure then chip away hardened epoxy. Surfaces shall be repaired to match existing finish to the satisfaction of the Owner's Representative.

3.9 PROTECTION

- A. Protect dowels from accidental disturbance during setting time specified by manufacturer.
- B. Do not place pull-out or shear loads on dowels during curing time specified by manufacturer.

3.10 FIELD QUALITY CONTROL

- A. Inspection and testing will be performed in accordance with procedures and administrative requirements of Division 01 Section, "Quality Requirements".
- B. Testing Laboratory will:
 - 1. Review manufacturer's recommended installation and inspection procedures, as contained in ICC Evaluation Service Report.
 - 2. Special Inspect installation for conformance with Contract Documents, manufacturer's recommendations, and requirements of the applicable ICC-ES report.

3. Test dowels in accordance with requirements of CBC Section 1910A.5 for adhesive anchors.
 - a. Testing Procedure: Use hydraulic ram testing procedure of CBC Section 1910A.5.5 for testing of bond (confined configuration).
 - b. Test Loads: As shown on Drawings, or as otherwise designated by Owner's Representative, in conformance with test load requirements CBC Section 1910A.5.4.
 - c. Testing Frequency: 100 percent, except frequency can be reduced in accordance with CBC Section 1910A.5.3.
 - d. Acceptance Criteria: Maintain test load for a minimum of 15 seconds with no discernible movement of dowel out of hole.

END OF SECTION

SECTION 050525 - POST-INSTALLED CONCRETE ANCHORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Post-installed mechanical anchors in concrete, including:
 - a. Wedge-type expansion anchors approved for use for seismic applications in cracked and uncracked concrete.
 - b. Screw-type drilled-in anchors approved for use for seismic applications in cracked and uncracked concrete.
 - 2. Post-installed adhesive anchors in concrete, approved for use for seismic applications in cracked and uncracked concrete.
- B. Related Sections:
 - 1. Section 036100 – Grouted Dowels: For threaded rods installed in hardened concrete using non-shrink grout.

1.3 REFERENCES

- A. ICC-ES or IAPMO-ES Evaluation Report: Evaluation Report issued by the ICC or IAPMO Evaluation Service demonstrating compliance with provisions of the 2021 International Building Code.

1.4 DEFINITIONS

- A. Nominal Embedment Depth (h-nom): Minimum length from concrete surface to bottom end of anchor upon initial of anchor installation. Nominal embedment depth is noted on construction documents.
- B. Effective Embedment Depth (h-ef): Minimum length from concrete surface to bottom of 'expansion clip' where the expansion anchor engages the concrete. At screw anchors, the effective embedment depth is reduced from nominal embedment depth to provide an accurate length where threads fully engage the concrete. Effective embedment depth is used in calculations only and is not shown on the construction documents.

1.5 SUBMITTALS

- A. General: Submit the following in accordance with Division 01, "Submittal Procedures".
 - 1. Manufacturer's product data.
 - 2. Manufacturer's installation instructions.
 - 3. ICC-ES or IAPMO-ES Evaluation Reports.

1.6 QUALITY ASSURANCE

- A. Certifications: Anchors shall have an active ICC-ES or IAMPPO-ES Evaluation Report in accordance with the following ICC-ES Acceptance Criteria:
 - 1. Mechanical Anchors in Concrete: Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC 193).

2. Adhesive Anchors in Concrete: Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (AC 308).

PART 2 – PRODUCTS

2.1 MECHANICAL ANCHORS

- A. General: Anchors shall be tested and approved for use in cracked and uncracked concrete in accordance with ICCES AC 193.
 1. Anchors installed through underside of steel deck shall be tested and approved for installation through the soffit of concrete-filled metal deck assemblies in accordance with ICC-ES AC 193.
 2. Anchors used for resistance to seismic forces shall be qualified in accordance to ACI 355.2 for mechanical anchors and ACI 355.4 for adhesive anchors.
- B. Acceptable Products: Where anchor manufacturer and product are indicated on Drawings, provide designated product.
 1. Contractor shall be allowed to substitute products of other manufacturer's, subject to demonstrating equivalent tension and shear strength to specified anchor, under project installation conditions.
 2. Where anchor design is prepared by Trade Subcontractor's Engineer, use product designated by Trade Subcontractor's Engineer, subject to meeting requirements of this Section.
- C. Wedge-type Anchors: Wedge type, torque-controlled expansion anchors. Size and nominal embedment depth as indicated on Drawings.
 1. Limitations: Use materials for locations as indicated below:
 - a. For use in dry interior environments: Case hardened low carbon steel, with zinc plating in accordance with ASTM B633, SC1, Type III, or Type 304 or Type 316 stainless steel, with manufacturer's matching nut and washer.
 - b. For locations exposed to weather and at building enclosure: Type 304 or Type 316 stainless steel only, with manufacturer's matching nut and washer.
 2. Acceptable Products: Where anchor product and manufacturer are not indicated on Drawings or designated by Trade Subcontractor's Engineer, provide one of the following:
 - a. Kwik Bolt TZ2, by Hilti, Inc.
 - b. Strong-Bolt 2, by Simpson Strong-Tie Co.
 - c. Power-Stud+ SD2, by Dewalt.
- D. Screw Anchors: Hardened steel, screw-type anchors or rod hangers approved for use in cracked and uncracked concrete. Diameter and nominal embedment depth as indicated on Drawings.
 1. Limitations: Use materials for locations as indicated below:
 - a. For use in dry interior environments: Case hardened low carbon steel, with zinc plating in accordance with ASTM B633, SC1, Type III, or mechanically galvanized in accordance with ASTM B695, Class 5, Type 1 or Type 304 or Type 316 stainless steel.
 - b. For use at pressure preservative treated lumber: ASTM B695, Class 65, Type I.
 - c. For locations exposed to weather and at building enclosure: Type 304 or Type 316 stainless steel only.
 2. Acceptable Products: Where anchor product and manufacturer are not indicated on Drawings or designated by Trade Subcontractor's Engineer, provide one of the following:
 - a. Kwik HUS EZ screw anchor and KH-EZ1 rod hanger, by Hilti.
 - b. Titen HD Screw Anchor and Titen HD Rod Hanger, by Simpson Strong-Tie Co. Inc.
 - c. ScrewBolt+, Hangermate+ Rod Hanger, and Snake+ screw anchor by Dewalt.

2.2 ADHESIVE ANCHORS

- A. Adhesive Anchors: Adhesive anchors include adhesive with proprietary inserts complete with nuts and washers intended for use with specified adhesive, or adhesive with non-proprietary threaded rod with matching size nut and washer.
- B. General: Anchors shall be tested and approved for use to resist seismic forces (IBC Seismic Design Categories A to F) in cracked and uncracked concrete in accordance with ICCES AC 308.
- C. Epoxy Adhesive: Two-component, 100% solids, structural epoxy conforming to ASTM C881, Type IV; Grade 3; prepackaged in cartridges for manually or pneumatically operated caulk gun and automatically mixed at nozzle. Approved for use in cracked and uncracked concrete in accordance with ICC or IAPMO Evaluation Service Report.
1. Where anchor manufacturer and product are indicated on Drawings, provide designated product.
 2. Contractor shall be allowed to substitute products of other manufacturer's, subject to demonstrating equivalent tension and shear strength to specified anchor, under project installation conditions.
 3. Where anchor design is prepared by Trade Subcontractor's Engineer, use product designated by Trade Subcontractor's Engineer, subject to meeting requirements of this Section.
 4. Acceptable Products: Where anchor product and manufacturer are not indicated on Drawings or designated by Trade Subcontractor's Engineer, provide one of the following:
 - a. HIT -RE500 V3 Epoxy Adhesive Anchoring System, by Hilti, Inc.
 - b. SET-3G Epoxy Adhesive, by Simpson Strong-Tie Co.
 - c. Pure 110+, by Dewalt.
- D. Acrylic Adhesive: Hybrid Adhesive: Two-component, hybrid adhesive prepackaged in cartridges for manually or pneumatically operated caulk gun and automatically mixed at nozzle. Approved for use in cracked and uncracked concrete in accordance with ICC ES AC308 or ACI 355.4, as demonstrated by an active ICC or IAPMO Evaluation Service Report.
1. Acceptable Products: Where anchor product and manufacturer are not indicated on Drawings or designated by Trade Subcontractor's Engineer, provide one of the following:
 - a. HIT -HY 200 Adhesive, Hilti Inc.
 - b. AT-3G Adhesive, Simpson Strong-Tie Co.
 - c. AC100+ Gold, Dewalt.
- E. Threaded Rod:
1. Material: Unless otherwise indicated on the Drawings, furnish carbon steel threaded rods conforming to ASTM 1554 Grade 36 or ASTM A193 Type B7. As indicated on the Drawings, provide Type 304 or Type 316 stainless steel anchors with manufacturers matching nut and washer.
 2. Finish: Furnish carbon steel rods with zinc plating in accordance with ASTM B633, SC1, Type III at dry interior locations. Furnish carbon steel rods with hot-dipped galvanized coating complying with ASTM A153 at exterior and damp interior locations, at pressure preservative treated wood, or where indicated on plans.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. General: Employ drilling and hole cleaning methods that comply with OSHA Code of Federal Regulations Standard 1926.1153, Respirable Crystalline Silica, Table 1. Reference: <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.1153> for more information.
1. Install anchors in conformance with manufacturer's written instructions.

B. Examination:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Notify Owner's Representative for clarification where reinforcing steel or other embedded items require relocation of anchors or cutting of reinforcement.
2. Notify Owner's Representative for clarification where anchors appear to be located too close to edge of concrete, in particular where edge is not shown on Drawing detail.
3. Notify Owner's Representative for clarification where concrete thickness is inadequate to achieve specified anchor embedment. Minimum concrete thickness shall be as indicated in ICC or IAPMO report for full anchor capacity. Where none included in report, or where minimum cover less than above, cover shall not be less than minimum thickness for reduced capacity. Allow for specified embedment, plus one anchor diameter allowance for overdrilling, plus 3/4 inch minimum cover from end of hole to concrete surface in all cases when determining minimum thickness for reduced capacity.

C. Drilling:

1. Do not drill holes in concrete mix has achieved full design strength.
2. Drill holes with rotary impact hammer drills using carbide-tipped bits with diameter as recommended by anchor manufacturer. Reduce impact as hole approaches concrete surface as necessary to prevent cracking and spalling. Use core bits only with approval of Owner's Representative. Roughen concrete surface at adhesive anchors.
3. Holes shall be drilled perpendicular to the concrete surface, unless otherwise shown on Drawings. Anchors shall be drilled to within 5 percent of specified alignment.
4. Exercise care in drilling to avoid damaging existing reinforcing, conduits and other embedded items.

D. Wedge-type Anchors:

1. Drill holes designated nominal embedment depth plus one anchor diameter minimum. End of hole shall be 3/4 inch minimum clear from concrete surface.
2. Remove dust and debris with pressurized air, in accordance with manufacturer's instructions.
3. Set anchors to designated nominal embedment depth, plus an allowance for withdrawal during torque tightening.
4. Tighten using a torque wrench to manufacturer's recommended installation torque. Following attainment of 10% of recommended torque, achieve 100% of designated torque within 5 or fewer turns of the nut. If torque is not achieved, the anchor shall be abandoned or removed if possible, and replaced unless otherwise directed by the Owner's Representative.

E. Screw Anchors:

1. Take particular care to achieve proper hole diameter. Use only sharp bits with diameter recommended by manufacturer. Use drilling equipment and methods to prevent enlargement of holes by drill bit wobble.
2. Remove dust and debris with pressurized air, in accordance with manufacturer's instructions.
3. Install the anchor in accordance with manufacturer's instructions with an impact wrench. Take care not to overtighten anchor; note that it is not necessary to reach the manufacturer's maximum installation torque for correct installation.

F. Adhesive Anchors:

1. Drill holes to diameter recommended by manufacturer with rotary impact hammer drills using carbide-tipped bits; core bits shall not be permitted.
2. Thoroughly clean holes in accordance with manufacturer's instructions and in compliance with OSHA requirements. Clean immediately prior to anchor installation under observation of Special Inspector.
3. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole.

4. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

3.2 REPAIR OF DEFECTIVE WORK

- A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

3.3 FIELD QUALITY CONTROL

- A. Testing Laboratory will:
 1. Review manufacturer's recommended installation and inspection procedures, as contained in Evaluation Service Report.
 2. Review Special Inspection Form.
 3. Special Inspect installation for conformance with Contract Documents, manufacturer's recommendations, and requirements of the applicable ES report. Verify that anchors are being installed by trained installers.
 - a. Periodically inspect installation of mechanical anchors.
 - b. Periodically or continuously inspect installation of adhesive anchors during hole cleaning and anchor installation as indicated on Special Inspection Form.
 4. Test anchors in accordance with requirements of CBC Section 1910A.5, including testing frequency and method for adhesive anchors.
 - a. Test Loads: As shown on Drawings, or as otherwise designated by Owner's Representative, in conformance with test load requirements CBC Section 1910A.5.4.
 - b. Testing Frequency, Structural Applications: 100 percent, except frequency can be reduced in accordance with CBC Section 1910A.5.3.
 - c. Testing Frequency, Equipment and Component Anchorage: 50 percent or alternate bolts in a group, including at least one-half of the anchors in each group shall be tested.

END OF SECTION

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Structural steel.
- B. Related Sections include the following:
 - 1. Section 031000 – Formwork, for installation of anchor rods (bolts) and other steel parts that are embedded in concrete to receive structural steel.
 - 2. Section 033000 – Cast in Place Concrete for grouting of baseplates and bearing plates.
 - 3. Section 053000 – Steel Decking for provision of shear connector studs that are field installed to tops of beams.

1.3 REFERENCES

- A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.
- B. American Institute of Steel Construction's
 - 1. AISC 303: Code of Standard Practice for Steel Buildings and Bridges, 2016.
 - a. The General Conditions, Special Conditions and Division 1 shall govern in the case of conflicts with provisions of the AISC 303.
 - 2. ANSI/AISC 341: Seismic Provisions for Structural Steel Buildings, 2016.
 - 3. ANSI/AISC 360: Specification for Structural Steel Buildings, 2016.
- C. American Welding Society's
 - 1. AWS C4.1: Criteria for Describing Oxygen-Cut Surfaces and Oxygen Cutting Surface Roughness Gauge, latest edition.
 - 2. AWS D1.1: Structural Welding Code, 2015.
 - 3. AWS D1.8: Structural Welding Code – Seismic Supplement, 2016.
- D. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where designated in this Section. Use applicable year of adoption or revision as published in AISC 360-16.
- E. Buy Clean California Act Environmental Product Declaration (EPD) Compliance Guide.
 - 1. By the California Department of General Services, latest edition.
<https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act>.
- F. CBC: 2022 California Building Code, including provisions applicable to DSA regulated facilities.
- G. CGBC – 2022 California Green Building Code

- H. Evaluation Report: Where designated in this Section, products shall have an active Evaluation Report evidencing compliance with provisions of the 2015 International Building Code. Reports by ICC Evaluation Service, Inc. or IAPMO shall be acceptable.
- I. Research Council on Structural Connections'
 - 1. RCSC Specification: Specification for Structural Joints Using High Strength Bolts, 2014.
- J. SSPC: Latest edition of Society for Protective Coatings surface preparation and painting specifications apply where cited in this Section.

1.4 DEFINITIONS

- A. Structural Steel: As classified by Section 2 of AISC 303.
- B. Protected Zone: Area of member, designated in Contract Documents, where limitations apply to the making of attachments by the fabricator, erector and other trades.
- C. Seismic Load Resisting System (SLRS): Members and connections designed to resist seismic forces, as designated on the drawings.
- D. Awarding Authority: The state authority under which a California state project is awarded. The University of California shall serve as the awarding authority for non-California state projects
- E. Product Category Rule: The set of rules, requirements, and guidelines accepted by the awarding authority used to develop on EPD for a product group.
- F. Environmental Product Declaration (EPD): Independently verified document that reports a product's global warming potential and that:
 - 1. Is developed according to the guidelines of the applicable Product Category Rule acceptable to the California State awarding authority. Reference [Buy Clean California Act](#).
 - 2. Is independently verified in accordance with ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations – Principles and procedures
- G. Manufacturer: An entity that produces the basic construction material that typically requires additional processing by a fabricator before use in a project.
 - 1. A steel mill that produces steel is a manufacturer.
 - 2. A facility that bends, welds, cuts, or otherwise shapes steel to be erected or otherwise installed in a location is a fabricator.
- H. Global Warming Potential (GWP): A measure of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, and perfluorocarbons produced when manufacturing a product represented by an equivalent amount of CO₂, expressed as CO₂ eq.
- I. Product Category Rule (PCR): The set of rules, requirements and guidelines used to develop an EPD for a product group.

1.5 SUBMITTALS

- A. Submittal procedures and administrative provisions are established by Division 01 Section "Submittal Procedures".
 - 1. Requirements of "Submittal Procedures" supersede provisions of Section 4.4 of AISC 303 Code, indicating time for review of shop drawings.
- B. Shop Drawings: Show complete information necessary for the fabrication and erection of structural-steel components in accordance with ANSI/AISC 360.

1. Identify surface preparation and finish.
- C. Mill Test Reports: Submit test reports certifying compliance with specified standards to Testing Laboratory for record purposes.
 1. Steel.
 2. Bolts, nuts and washers.
 3. Welding filler materials, fluxes and shielding gases.
 4. Shear connector studs.
- D. Product Data: For each type of product indicated, including but not limited to weld filler materials, shop primers, bar couplers and deformed bar anchors.
- E. Welder Performance Qualification Records (WPQR's). Submit to Testing Laboratory for record purpose.
- F. Welding Procedure Specification (WPS) for each different welded joint proposed for use, whether prequalified or qualified by testing.
 1. Prepare in accordance with AWS D1.1 requirements.
 2. Include procedure qualification record (PQR) for procedures qualified by testing.
 3. For Demand Critical welds, conform to additional requirements of AWS D1.8.
 4. Allow sufficient time for review by Testing Laboratory in addition to review by Owner's Representative.
- G. High strength bolt installation procedure.
- H. Environmental Product Declarations (EPDs) for all steel.
 1. Provide manufacturer's single-facility EPD or company-wide EPD that reports for each facility location supplying material.
 - a. EPD must be valid at the time of material installation.
 - b. The following EPDs are not acceptable:
 - 1) Industrywide and/or industry-average product declarations.
 - 2) Fabricator's product declarations.
 - 3) Companywide declarations that do not report the GWP of its manufacturing facilities separately.
 2. Include at a minimum:
 - a. Product description
 - b. Product category rule under which the EPD was developed.
 - c. Body verifying that the EPD was developed according to ISO 14025 for the applicable PCR.
 - d. Expiration date
 - e. Manufacturer and manufacturer's location
 - f. Global warming potential measured in CO₂ eq.
 3. EPD must be valid at the time of material installation
- I. Samples: As requested by the Testing Laboratory.

1.6 QUALITY ASSURANCE

- A. Comply with applicable provisions of AISC 303, ANSI/AISC 341, ANSI/AISC 360, except where more stringent requirements are shown or specified.
- B. Fabricator Qualifications: Qualify by either of the following:
 1. A qualified fabricator who participates in the AISC Certification Program and is designated an AISC Certified Plant, Category " BU" at time of bid.
 2. A fabricator having a minimum of five years' experience in structural steel framed building projects of similar size and designed for similar seismic demands. Similar size shall be project having no

less than 90% square footage of this project. Similar seismic demands shall be projects designed for a short period pseudo acceleration, S_{DS} , of x.xx g or greater.

- C. Qualifications for Welding Work: Qualify welding procedures and welding operators in accordance with AWS D1.1.
 - 1. Welders performing Demand Critical welds made through a beam web access hole or gusset plate access hole shall have Supplemental Welder Qualification for Restricted Welding in accordance with AWS D1.8.

1.7 COORDINATION

- A. Provide metal templates and setting drawings for installation of anchorage items embedded in other work.
- B. Furnish embedded anchorage items to avoid delays to other Work.
- C. Survey embedded items for proper location prior to delivery of steel.

PART 2 – PRODUCTS

2.1 STEEL MATERIALS

- A. General: All steel shall be identified as required by CBC Section 2202.1. Steel that is not properly identified shall be tested to show conformance with requirements of applicable ASTM Standard at Contractor's expense.
- B. Hot rolled structural steel sections, hollow structural steel sections, and steel plate shall meet the GWP limits included in Table 1 of the Buy Clean California Act Environmental Product Declaration (EPD) Compliance Guide, and of CGBC Table 5.409.3.
- C. W-Shapes: ASTM A992.
 - 1. Supply Charpy V-Notch impact testing for members of the Seismic Load Resisting System with flanges 1-1/2 inches thick or thicker. Steel shall evidence a minimum average value of 20 ft-lbs at +70 deg F when tested in accordance with ASTM A6, Supplementary Requirement S30.
 - 2. Furnish shapes conforming to ASTM A913, Grade 65 where designated on drawings.
- D. Channels and Angles: ASTM A36; except ASTM A572, Grade 50 may be substituted at Fabricator's option to suit material availability.
 - 1. Furnish ASTM A572, Grade 50 material where designated on drawings.
- E. Plates and Bars: Furnish Grade 50 material, unless otherwise designated.
 - 1. Grade 50: ASTM A572, Grade 50; ASTM A588, Grade 50; or ASTM A529, Grade 50 or Grade 55.
 - 2. Grade 36: ASTM A36.
 - a. Where designates on drawings.
 - 3. Grade 42: ASTM A572, Grade 42, or ASTM A588 for baseplates thicker than 4 inches.
 - 4. Supply Charpy V-Notch impact testing, in accordance with ASTM A6, Supplementary Requirement S5, for plates 2 inches thick or thicker used in the Seismic Load Resisting System. Steel shall minimum average value of 20 ft-lbs at +70 deg F when tested in accordance with ASTM A673, Frequency P. Requirement applies to the following:
 - a. Plates for built-up members used in the SLRS.
 - b. Baseplates for SLRS columns.
 - c. SLRS connection plates, including continuity plates and gusset plates.
- F. Pipes: ASTM A53, Type E, Grade B.

- G. Hollow Structural Steel:
1. Square and rectangular HSS: ASTM A500 Grade C.
 2. Round HSS: ASTM A500, Grade B or Grade C.

2.2 BOLTS, ANCHORS AND CONNECTORS

- A. High Strength Bolts: One of the following, unless otherwise designated on Drawings.
1. ASTM F3125, Grade 325, Type 1, heavy hex structural bolts with ASTM A563, Grade C or DH heavy hex nuts and ASTM F436 hardened washers.
 2. ASTM F3125, Grade F1852, Type 1, round head tension control bolts with ASTM A563, Grade C or Grade DH heavy hex nuts and ASTM F436 hardened washers.
- B. A 490 Bolts: Provide where designated on Drawings.
1. ASTM F3125, Grade A490, Type 1, heavy hex structural bolts with ASTM A563, Grade DH heavy hex nuts; ASTM F436 hardened washers, and ASTM F959, Type 490 direct-tension indicator washers.
 2. ASTM F3125, Grade F2280, Type 1, round head tension control bolts with ASTM A563, Grade DH heavy hex nuts and ASTM F436 hardened washers.
- C. ASTM A307 Bolts: ASTM A307, Grade A, hex headed bolts furnished with ASTM A563, Grade A, hex nuts.
- D. Anchor Rod Assembly:
1. Anchor rod: ASTM F1554, Grade 36; end threaded.
 2. Head: Form head with ASTM A563, Grade A, heavy hex nut. Lock against loosening with suitable jam nut.
 3. Nuts: ASTM A563, Grade A, heavy hex.
 4. Washer: Provide steel plate washer of sufficient size to completely cover hole in baseplate; minimum thickness shall be 1/3 of bolt diameter.
- E. High Strength Anchor Rod Assembly:
1. Anchor rod: ASTM F1554, Grade 105, with Supplementary Requirement S4, "Grades 55 and 105 Charpy Impact Requirements of 15 foot-pounds at +40 deg F." Mark exposed end in accordance with Supplementary Requirement S3, "Permanent Grade Identification".
 2. Head: Form head with round steel plate washer sandwiched between ASTM A563, Grade DH, heavy hex nuts. Plate washer size shall be 3 times bolt diameter and thickness shall be 1/2 of the bolt diameter, unless otherwise designated.
 3. Nuts: ASTM A563, Grade Dh, heavy hex, or ASTM A194, Grade 2H, heavy hex.
 4. Washer: Provide steel plate washer of sufficient size to completely cover hole in baseplate; minimum thickness shall be 1/3 of bolt diameter.
- F. Reinforcing Bar Couplers: Weldable half couplers for joining reinforcing bars to structural steel. Acceptable products shall have an active Evaluation Report evidencing code compliance for full mechanical tension splice. Acceptable Products: Lenton Weldable Coupler C3J/C2 by Erico, or approved equal.
- G. Deformed Bar Anchors: Fabricated from deformed wire conforming to ASTM A1064, 70 ksi minimum yield strength. Acceptable Products: Deformed Bar Anchor Studs by Nelson Stud Manufacturing, or approved equal.
1. Substitution of ASTM A706 bars of equal size will be permitted, subject to approval of welding procedure by Owner's Representative.
- H. Threaded Rods: ASTM A36 end threaded round bar. Nuts shall conform to ASTM A563, Grade A, hex.
1. Accessories, including clevises and turnbuckles, shall conform to ASTM A108, Grade 1035, cold-finished carbon steel; and capable of developing specified tensile strength of rod.

2.3 WELDING CONSUMABLES

- A. General: Filler materials and fluxes shall conform to requirements of AWS D1.1; of suitable type for base metals being welded and the intended application.
 - 1. Electrodes for SMAW shall be low hydrogen.
- B. Filler and weld metal used for welds of Seismic Lateral Resisting System (SLRS) members and connections shall conform to additional requirements of AWS D1.8, Section 6.1.
- C. Filler and weld metal used for complete-joint-penetration Demand Critical welds shall conform to additional requirements of AWS D1.8, Sections 6.2, 6.3, and 6.4.

2.4 OTHER ITEMS

- A. Primer Paints:
 - 1. Primer paints listed below shall only be used where VOC limits of locale where primer is applied to steel are not exceeded. Contractor shall apply listed primer paints in such locales.
 - 2. Type A Primer: Fast-drying, rust-inhibitive, chromate- and lead-free modified alkyd primer. Acceptable Products: Series V10 by Tnemec, 42 Series by Maclac, or approved equal
 - 3. Type B Primer: SSPC-Paint 20, Type II. Organic, zinc-rich primer; containing less than 0.002% lead. Acceptable Products: Series 90-97 Tneme-Zinc by Tnemec, Carbozinc 621 by Carboline, or approved equal.
- B. Galvanizing Repair Paint: ASTM A780.

2.5 FABRICATION

- A. Fabricate structural steel in accordance with AISC 303 and ANSI/AISC 360.
 - 1. Conform to additional requirements of ANSI/AISC 341 for members and connections of the Seismic Load Resisting System.
 - 2. Conform to additional requirements of Section 05 12 10 - Architecturally Exposed Structural Steel for AESS members and connections.
- B. Thermal Cutting:
 - 1. Make cuts by machine or using mechanical guide.
 - 2. Processes shall be limited to Plasma Arc or Oxyfuel Gas processes, except as approved by Owner's Representative.
 - 3. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- D. High Strength Bolted Connections: Install bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts" for type of bolt and joint specified.
 - 1. Bolt installation: Pretensioned, except where otherwise designated on Drawings.
 - 2. Faying surfaces: Class A surfaces, in accordance with requirements for slip-critical connections.
 - 3. Hole type: Standard, except where designated on Drawings.
 - a. Do not punch holes in material greater than 1/2 inch in thickness, unless approved in writing by Owner's Representative.
- E. Welding:
 - 1. Weld in accordance with ANSI/AISC 360 and AWS D1.1 using manual shielded arc method (SMAW), flux cored arc method (FCAW), or gas shielded arc method (GMAW).
 - 2. Weld in accordance with welding procedure specifications (WPS's) for joint, which are to be available to welders and inspectors during the production process.

3. Groove welds shall be complete joint penetration welds, unless designated otherwise on drawings. Groove preparation is at Contractor's option, subject to qualification in accordance with AWS D1.1.
 - a. Use double bevel groove welds for sections thicker than 1-1/2 inches, wherever practical.
 4. Partial penetration welds shall have an effective throat thickness as designated on drawings. Groove preparation is at Contractor's option, subject to qualification in accordance with AWS D1.1.
 5. End dams shall not be used, except at the outboard end of weld tabs that are removed. Provide beveled transitions at changes in groove profile.
 6. For members and connections of the Seismic Load Resisting System (SLRS), conform to supplemental requirements of AWS D1.8 and the following:
 - a. Use filler materials specified for SLRS welds.
 - b. Weld access holes for complete penetration beam flange to column connections shall be shaped in accordance with AWS D1.8, Paragraph 6.11.1.2, "Alternate Geometry"; and conform to quality requirements of Paragraph 611.2.
 7. Demand Critical welds: Conform to requirements for welding of members and connections of the SLRS, the supplemental requirements of AWS D1.8 applicable to Demand Critical welds, and the following:
 - a. Use filler materials specified for Demand Critical welds.
 - b. Complete penetration welds made through access holes in member webs or gusset plates shall follow the welding sequence of AWS D1.8, Paragraph 6.14.
 - c. Remove backing bars where designated on drawings.
 - d. Provide a reinforcing fillet at locations where backing bars are removed.
 - e. Butt joints of parts of unequal thickness or width, shall have a smooth transition between offset surfaces in accordance with provisions of AWS D1.1 for tension joints.
 8. Weld reinforcing steel bar couplers to structural steel in accordance with AWS D1.1 using qualified procedures and in accordance with manufacturer's recommendations.
- F. Studs: Automatically end weld headed studs and deformed bar anchors in accordance with AWS D1.1 and manufacturer's recommendations in such a manner as to provide complete fusion between the end of the stud and steel member.

2.6 FINISHES

- A. General:
1. Cleaning: All steel shall be free of oil and grease. Clean as required in accordance with SSPC SP1 "Solvent Cleaning".
 2. Preparation: All steel shall be free of loose mill scale and foreign matter. Clean as required by SSPC SP 2 "Hand Tool Cleaning".
- B. Unpainted: Structural steel at the building interior that is concealed by finishes or fireproofed in the completed construction may remain unpainted.
1. Steel may be prime painted at Contractor's option, except for the following:
 - a. Members to receive spray fireproofing.
 - b. Top surfaces of beams to receive welded shear connector studs or weld-attached steel deck.
 - c. Surfaces in contact with concrete, except initial two inches.
 - d. Faying surfaces of high strength bolted connections.
 - e. Surfaces within 1 inch of field weld locations.
- C. Interior Prime Painted: Prime paint interior surfaces that will remain visible in the completed construction, including steel at penthouses.
1. Do not paint faying surfaces of high strength bolted connections and within 1 inch of field weld locations.

- D. Exterior Prime Painted: Prime paint surfaces that are outside the weatherproof envelope, including concealed surfaces.
 - 1. Surface preparation: SSPC SP6 "Commercial Blast Cleaning". Ease corners of plates and shapes to 1/16-inch minimum chamfer.
 - 2. Primer: Type B, at 3 mils dry film thickness. Verify that primer is compatible with finish painting systems.
 - 3. Do not paint within 1 inch of field weld locations; paint faying surfaces of bolted connections.
 - 4. Schedule application of intermediate coats prior to erection, where steel cannot be properly field coated after erection.

- E. Hot-Dip Galvanizing: Hot dip galvanize items designated on drawings.
 - 1. Galvanize items in accordance with ASTM A123.
 - 2. Provide hot dip galvanized fasteners for connection of galvanized items, except do not galvanize A490 bolts. Galvanize in accordance with ASTM A153, Grade 50.
 - 3. Obtain approval for locations of vent holes in closed sections.

2.7 SOURCE QUALITY CONTROL

- A. Inspection and testing will be performed in accordance with procedures and administrative requirements of Division 01 Section, "Quality Requirements".

- B. Special Inspection and testing shall be made in accordance with CBC Section 1705.2, AISC 360, and AISC 341.

- C. Testing Laboratory will:
 - 1. Collect and review material test reports and certificates in accordance with AISC 360 chapter N3.2 including but not necessarily limited to:
 - a. Material test reports for structural steel elements, steel castings and forgings, anchor rods and threaded rods verifying compliance with specified requirements.
 - b. Certificates for fasteners, welding consumables, and headed studs, verifying compliance with specified requirements.
 - c. Review welding procedure specifications for compliance with applicable requirements of AWS D1.1 and AWS D1.8.
 - 1) Verify that machine settings and travel speed correspond to electrode manufacturer's recommendations.
 - d. Review procedure qualification records for weld procedure specifications that are not prequalified in accordance with AWS D1.1.
 - e. Collect and review qualifications of welders.
 - f. Review material identification and control procedures for conformance with requirements of the CBC Section 2203.1, AISC 360.N2, and AISC 303.6.1
 - 2. Inspect high-strength bolting in accordance with requirements of AISC 360 Chapter N5.6 "Inspection of High Strength Bolting".
 - a. Perform additional QA inspection tasks and documents listed in ANSI/AISC 341, Section J7, "Inspection of Bolting" for Seismic Force Resisting System member connections.
 - 3. Inspect shop and field welding in accordance with requirements of AISC 360 Chapter N.5.4 "Inspection of Welding".
 - a. Perform additional QA inspection tasks listed in ANSI/AISC 341, Section J6.1, "Visual Welding Inspection" for Seismic Force Resisting System member connections.
 - 4. Ultrasonic test 100 percent of complete joint penetration welds in materials 5/16-inch or greater. Perform testing in accordance with procedures and acceptance criteria of AWS D1.8, Section 7.10, "Ultrasonic Testing".
 - a. Apply requirements for seismic connections to all connections.

- b. Subject to approval of authority having jurisdiction, the amount of testing will be permitted to be reduced in accordance with provisions of ANSI/AISC 341, Section J, paragraph J6.2g, "Reduction of Percentage of Ultrasonic Testing".
- 5. For members and connections of the Seismic Force Resisting System, perform additional nondestructive testing (NDT) of welds and base metal adjacent to welds in accordance with provisions of ANSI/AISC 341, Section J, paragraph J6.2. Perform tests in accordance with applicable requirements of AWS D1.8, Section 7, "Inspection".
 - a. MT inspection of k-area base metal in web, where welding of continuity plates, doubler plates or stiffener plates occurs in k area.
 - b. MT inspection of beam-to-column CJP's.
 - c. UT testing of base metal, including baseplates, thicker than 1-1/2 inches for laminations where connected material is greater than 3/4 inches.
 - d. MT testing of beam copes and access holes at welded connections where flanges are thicker than 1-1/2 inches.
- 6. Inspect RBS flange cuts for conformance with specified requirements for contour and finish.
- 7. Periodically, inspect and test stud welding as required by CBC, in accordance with AWS D1.1. Sections 7.7 and 7.8. Review pre-production testing and qualification, periodically inspect welding, and perform verification inspection and testing.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine construction to support steel erection and verify the following:
 - 1. Location and elevation of bearings and anchor bolts are correct.
 - 2. Other conditions adversely affecting erection of steel are absent.
- B. Do not begin erection before unsatisfactory conditions have been corrected.

3.2 ERECTION

- A. Erect structural steel in accordance with AISC 303 and ANSI/AISC 360.
 - 1. Conform to additional requirements of ANSI/AISC 341 for members and connections of the Seismic Load Resisting System.
 - 2. Conform to additional requirements of Section 051210 - Architecturally Exposed Structural Steel for AESS members and connections.
- B. Where erection requires performing work of fabrication on site, conform to applicable requirements of "Fabrication".
 - 1. Thermally cut edges shall be made with mechanical guides and meet requirements of AWS D1.1, Section 5.14 for acceptable roughness, notches and gouges.
- C. Field corrections will not be permitted without the prior approval of the Owner's Representative.
- D. Field Touch-up Painting:
 - 1. Touch-up paint field welded connections and abrasions using same paint used for shop priming.
 - 2. Prior to painting welds, thoroughly chip and wire brush. Wash with dilute solution of phosphoric acid (approximately 5%) and rinse with water. Allow surface to dry prior to painting.
 - 3. Touch up galvanized surfaces in accordance with ASTM A780.

3.3 CLEANING

- A. After erection, thoroughly clean surfaces of foreign or deleterious matter such as dirt, mud, oil, or grease that would impair bonding of fire-retardant coating, paint or concrete.

3.4 PROTECTION

- A. Maintain warning signage for Protected Zones during construction period.
 - 1. Install temporary signage prior to erection.
 - 2. Install permanent signage as soon as practical following the masking of temporary signage by spray fireproofing or finish painting.

3.5 FIELD QUALITY CONTROL

- A. Inspection and testing will be performed in accordance with procedures and administrative requirements of Division 01 Section, "Quality Requirements".
- B. Testing Laboratory will:
 - 1. Inspect and test field high strength bolting and welding in accordance with "Source Quality Control".
 - 2. Inspect Protected Zones for:
 - a. Discontinuities created by fabrication or erection operation, such as tack welds and erection aids.
 - b. Welded shear stud and decking attachments, except deck spot welds shall be permitted.
 - c. Welded, bolted, screwed, or shot in attachments for attachment of edge angles and the Work of other trades.
 - d. Placement of suitable warning signage.

END OF SECTION

SECTION 053100 - STEEL DECKING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Composite steel floor deck.
 - 2. Steel roof deck.
 - 3. Deck accessories.
 - 4. Reinforcement for small openings.
 - 5. Shear connector studs for composite beam construction.

1.3 REFERENCES

- A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.
- B. American Iron and Steel Institute's
 - 1. AISI-NAS – Specification for the Design of Cold-Formed Steel Structural Members, 2020 Edition.
- C. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where designated in this Section. Use applicable year of adoption or revision as published in the AISI-NAS.
- D. American Welding Society's
 - 1. AWS D1.1: Structural Welding Code, 2015.
 - 2. AWS D1.3: Structural Welding Code - Sheet Steel, 2008.
- E. CBC: 2022 California Building Code.
- F. ESR: Where designated in this Section, products shall have an active Evaluation Service Report evidencing compliance with provisions of the 2021 International Building Code. Reports by ICC and IAPMO shall be considered acceptable.
- G. Steel Deck Institute's
 - 1. ANSI/SDI C-2017: Standard for Composite Steel Floor Deck-Slabs, 2017.
 - 2. ANSI/SDI RD-2017: Standard for Steel Roof Deck-Slabs, 2017.
 - 3. ANSI/SDI QA/QC-2017: Standard for Quality Control and Quality Assurance for Installation of Steel Deck.
- H. Underwriters Laboratories (UL) "Fire Resistance Directory".

1.4 DEFINITIONS

- A. Floor Deck: W series deck to receive concrete fill. May be used for roof construction.

1.5 SUBMITTALS

- A. Submittal procedures and administrative provisions are established by Division 01 Section "Submittals".

- B. Product data, including manufacturer's certification to show compliance with these specifications.
 - 1. Steel deck.
 - 2. Shear connector studs and deformed bar anchors.
 - 3. Welding electrodes.
 - 4. Mechanical fasteners.
- C. Welding procedure specifications.
- D. Welder Qualifications: Submit to Testing Laboratory for record purposes.
- E. Shop Drawings: Show deck layout, framing and supports; type, location and large scale details of attachments and seam connections; sections and details at openings, edges and accessories; size and location of shear connector studs. Show location of die-set ends to accept end laps at roof deck.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Welding procedures and welders shall be qualified in accordance with AWS D1.3.
- B. Provide deck units that have been evaluated by an Evaluation Service acceptable to the Owner's Representative and are listed in an active ESR report.
- C. Where deck is designated as part of a fire-resistive assembly, deck shall have been tested for fire resistance per ASTM E119 as a part of an assembly of the type used for the project and shall be listed in the UL "Fire Resistance Directory".

1.7 DELIVERY, STORAGE AND HANDLING

- A. Handle and store decking in manner to prevent bending of deck units.
- B. Store off ground with one end elevated for drainage, and cover with waterproof material, ventilated to avoid condensation.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Verco Decking, Inc.
- B. ASC Steel Deck.
- C. Other Manufacturers with an active Evaluation Service Report evidencing compliance with requirements of the Drawings and these specifications.

2.2 MATERIALS

- A. Sheet Steel: Sheet steel shall conform to ASTM A653 Structural Quality, G60 zinc coated, unless otherwise indicated.
 - 1. Sheet steel, 10 gage and thicker: ASTM A1008, Designation SS grade 33.
 - 2. Refer to Division 9 for primer at sheet steel to receive finish paint.
- B. Welding Materials: AWS D1.3.
- C. Shear Connector Studs: AWS D1.1, Type B headed studs with ferrule for through-deck application; 3/4 inch diameter unless otherwise noted, as welded length as noted on Drawings.

- D. Steel Angles and (bent) Plates: ASTM A36; uncoated finish, unless otherwise noted.
- E. Deformed Bar Anchors: Fabricated from deformed wire conforming to ASTM A496, 70 ksi minimum yield strength. Provide special ferrules, as recommended by manufacturer, for welding positions other than downhand. Acceptable Products: Deformed Bar Anchor Studs by Nelson Stud Manufacturing, Deformed Bar Anchors by Tru-weld.
- F. Galvanizing Repair Paint: SSPC Paint 20 with dry film containing a minimum of 94 percent zinc dust by weight.

2.3 DECK TYPES

- A. General Requirements:
 - 1. Refer to Drawings for required deck profiles, steel sheet thickness, minimum section properties, and minimum allowable load capacity.
 - 2. Section design properties shall be determined in accordance with applicable requirements of AISI-NAS.
- B. Floor Deck: Composite steel deck having deformations to provide a mechanical bond with the concrete.
 - 1. Design in accordance with SDI C-2011. Composite deck shall be capable of providing allowable superimposed load rating specified on Drawings.
 - 2. Provide manufacturer's standard vent tabs, providing one percent open area, at floors. Composite deck used for roof construction need not be vented.
- C. Roof Deck:
 - 1. Design in accordance with SDI RD-2010.
 - 2. Steel deck shall be capable of providing allowable diaphragm shear capacity specified on Drawings.

2.4 DECK ACCESSORIES

- A. General: Provide manufacturer's standard type accessories of same material as deck, except as otherwise designated.
- B. Adjusting Plates: Provide as required at beams running parallel to deck flutes.
 - 1. Provide minimum 16 gage filler with edge lip that provides for standard side-lap attachment.
 - 2. Provide minimum 14 gage filler without edge lip where deck attaches to filler with arc seam, flare groove, or fillet weld.
- C. Pour Stops: Provide bent sheet steel pour stops at all edges of sufficient strength and stiffness to support wet concrete. Where sheet thickness is not designated on Drawings, conform to recommendations of SDI C-2011, Attachment 1.
 - 1. Provide minimum 10 gage pour stops at building perimeter.
 - 2. Provide minimum 16 gage pour stops at framed openings at building interior.
- D. Cell Closures: Provide tight fitting 18 gage closures at open ends of ribs, including at changes of floor deck units. Maintain minimum 4 inches clear between closures at down flutes.
- E. Column Closures: Provide tight filling sheet steel closures at columns.
- F. Collars: Where deck is cut prior to placement of concrete fill for passage of pipes, ducts, etc. provide minimum 18 gage sheet steel collar to cover edges of deck and form opening.

G. Roof Deck Accessories:

1. Provide minimum 16 gage by 3 inch wide cover plate, at butted end joints of deck, including but not limited to ridge and valley conditions. Furnish in minimum 8 foot lengths.
2. Provide manufacturer's standard diaphragm shear transfer devices where designated on drawings.
3. Provide closures, ridge and valley plates, sump pans, and cant strips, as required to provide a finished surface to receive roof insulation.

2.5 FABRICATION

- A. Fabricate steel decking in accordance with SDI C-2011 (composite floor deck) or SDI RD-2010 (roof deck).
1. Fabricate panels with interlocking side laps, suitable for specified side-lap attachment method.
- B. Provide in lengths to be continuous for three spans and rest on a minimum of four supports, wherever steel layout permits. Where decking cannot be continuous for two spans, increase deck gage as required to support temporary loads at acceptable deflections.
- C. Conform to tolerances of SDI C-2011 (composite floor deck) or SDI RD-2010 (roof deck).

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine construction to support decking to verify that setting conditions are proper.
- B. Verify that surfaces to receive decking are clean and otherwise suitable to receive deck attachments.
- C. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install decking in accordance with Contract Documents, SDI C-2011 (composite floor deck) or SDI RD-2010 (roof deck), and manufacturer's recommendations.
- B. Locate end joints over supporting members and ensure not less than two inches bearing of each panel on support.
1. Butt end joints of floor deck tight at center line of structural support.
 2. Lap end joints of roof deck not less than two inches, unless otherwise noted.
- C. Secure deck to steel supporting members with arc spot (puddle) welds or arc seam welds, or approved powder driven fasteners, as designated on Drawings or approved by Owner's Representative. Take special care to secure solid attachment where deck is warped or sloped.
1. Perform welding in accordance with AWS D1.3.
 2. Puddle welds shall have a minimum effective fusion area of 1/2 inches in diameter and a visible diameter of 5/8 inch at surface. Arc seam welds shall have a minimum effective fusion area of 3/8 inches by 1 inch. Weld metal shall penetrate all layers of deck material and shall have good fusion to supporting members.
 3. Shear connector studs welded through deck replace deck puddle welds on a one-for-one basis, wherever there is one inch minimum clearance from stud centerline to edge of deck.
- D. Connect sidelaps of floor deck to receive structural concrete fill as indicated on Contract Drawings.
1. Top Seam Weld: Clinch first to get contact of lips and make 1½ inch long weld which engages top of inner leg.
 2. Specialty Sidelap Connection: VSC connection made with PunchLok tool by Verco Decking, DeltaGrip connection by ASC Steel Deck, or approved equal by other manufacturers.

3. Button Punch: Use hand or pneumatic tool intended to button punch steel deck side laps. Adjust button depth to provide fully interlocking punches without tear-through. Ensure lips are fully engaged, follow behind punching, standing on punched deck. Do not walk in front of punching process.

- E. Connect sidelaps of roof deck, including roof deck to receive insulating concrete fill, using top seam welds at spacing designated on Drawings.
 1. Top Seam Weld: Clinch first to get contact of lips and make 1½ inch long weld which engages top of inner leg.
 2. Touch-up paint welds at roof deck.

- F. Shear Connector Studs: Automatically end weld in accordance with AWS D1.1 and manufacturer's recommendations in such a manner as to provide complete fusion between the end of the stud and steel member. There shall be no porosity or evidence of lack of fusion between the end of the stud and the steel member.
 1. Studs welded to beams framing perpendicular to deck flutes shall be placed as close as practical to center of deck flute.

- G. Reinforce small openings as indicated on Drawings, making welded connections in accordance with AWS D1.3.

3.3 FIELD QUALITY CONTROL

- A. Inspection and testing will be performed under in accordance with procedures and administrative requirements of Division 01 Section "Quality Requirements".

- B. Testing Laboratory shall:
 1. Special inspect deck installation for conformance to Quality Assurance requirements of SDI QA/QC – 2017.
 2. Periodically inspect and test deck welding as required by CBC Chapter 17 in accordance with AWS D1.3. Review materials and qualification of welders and procedures prior to start of work, periodically inspect welding in progress, and perform final visual inspection of all welds.
 3. Periodically inspect and test welding of shear connector studs as required by CBC Chapter 17, in accordance with AWS D1.1.

END OF SECTION

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Exterior non-load-bearing wall framing.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
 - 2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
 - 3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Cold-formed steel framing materials.
 - 2. Post-installed anchors.
 - 3. Power-actuated anchors.
- B. Shop Drawings:
 - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.
 - 1. Steel sheet.
 - 2. Expansion anchors.
 - 3. Power-actuated anchors.
 - 4. Mechanical fasteners.
 - 5. Miscellaneous structural clips and accessories.
- C. Research Reports:
 - 1. For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- E. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. CEMCO; California Expanded Metal Products Co.
 - 2. ClarkDietrich.
 - 3. Olmar Supply, Inc.
 - 4. SCAFCO Steel Stud Company.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: As indicated on Drawings.
 - 2. Deflection Limits: Design framing systems to withstand design loads indicated on Drawings without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of L/240 of the wall height.
 - 3. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4 inch.
 - 4. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- B. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and AISI S240.
- C. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Framing Members, General: Comply with AISI S240 for conditions indicated.
- B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
 - 1. Grade: As required by structural performance.
 - 2. Coating: G60, A60, AZ50, or GF30.

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: As indicated or required by performance requirements, but not less than 18 gauge.
 - 2. Flange Width: 1-3/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: As indicated or required by performance requirements, but not less than 18 gauge.
 - 2. Flange Width: 1-1/2 inches.
- C. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: As indicated or required by performance requirements, but not less than 18 gauge.
 - 2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.
- D. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
 - 1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - a. Minimum Base-Metal Thickness: As indicated or required by performance requirements, but not less than 18 gauge.
 - b. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.
 - 2. Inner Track: Of web depth indicated, and as follows:
 - a. Minimum Base-Metal Thickness: As indicated or required by performance requirements..
 - b. Flange Width: Dimension equal to sum of outer deflection track flange width plus 1 inch.

2.5 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

2.6 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

- B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.
- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.
 - 1. Uses: Securing cold-formed steel framing to structure.
 - 2. Type: Torque-controlled expansion anchor, torque-controlled adhesive anchor or adhesive anchor.
 - 3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 or Group 2 stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780/A780M MIL-P-21035B SSPC-Paint 20.
- B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

2.8 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.
- C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

- b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: As indicated on Drawings, but not more than 16 inches on center
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
- E. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

- A. Field and shop welds will be subject to testing and inspecting.

- B. Cold-formed steel framing will be considered defective if it does not pass inspections.
- C. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Steel framing and supports for countertops.
 2. Steel framing and supports for mechanical and electrical equipment where framing and supports are not specified in other Sections.
 3. Slotted-channel framing for equipment support applications where slotted-channel framing and supports are not specified in other Sections.
 4. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 5. Metal ladders.

1.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for metal fabrications.
1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and attachment to building structure, and accessory items. Include shop drawings for the following:
 - a. Miscellaneous framing and supports for applications and support of equipment where framing and supports are not specified in other Sections.
 - b. Steel framing and supports for countertops, unless manufactured brackets are proposed.
 - c. Metal ladders.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Provide the following upon request:
1. Welding certificates.
 2. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Criteria for the design and installation of lateral force anchorage for non-structural components of the Project including walls, cladding, ladders, mechanical and electrical equipment supports, ductwork hangers, piping supports, and other miscellaneous supports as identified in Tables 13.5-1 and 13.6-1 of ASCE 7 and the programmatic equipment installed under these contract documents shall be restrained to resist lateral forces in accordance with the following requirements, unless otherwise indicated:
 - 1. The bracing and anchorage of all building related or conventional non-structural elements, shall comply with Chapter 13 of ASCE 7.
 - 2. Equipment that is not attached to a building structure or supported by a non-building structure covered in Chapter 15 of ASCE 7 shall be designed per the provisions of Chapter 13. Either Chapter 13 or 15 can be used to design non-building structures that are inside buildings and are only attached to the building's foundation.
 - 3. Refer to structural drawings.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
 - 1. Galvanize steel where exposed to weather and where indicated.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches unless otherwise required by performance requirements and equipment loads.
 - 2. Material: Galvanized steel, ASTM A 653/A 653M, , with G90 coating; 0.108-inch nominal thickness unless otherwise required by performance requirements and equipment loads.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Machine Screws: ASME B18.6.3.
- D. Lag Screws: ASME B18.2.1.

- E. Plain Washers: Round, ASME B18.22.1.
- F. Lock Washers: Helical, spring type, ASME B18.21.1.
- G. Anchors, General: Anchors tested in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), which incorporate requirements in ACI 355.2/ACI 255.2 for use in cracked and uncracked concrete.
- H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) or Group 2 (A4) stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Shop Primer: Refer to Section 099123 "Interior Painting," Section 099113 "Exterior Painting," or Section 099600 "High-Performance Coatings" to suit application.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts for units installed after concrete is placed.
- C. Prime interior miscellaneous framing and supports with zinc-rich primer. Paint exposed metal.
- D. Galvanize and prime steel supports exposed to water sources and exterior. Paint exposed metal.

2.7 METAL LADDERS

- A. General:
1. Comply with ANSI A14.3, except for elevator pit ladders.
 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.
- B. Steel Ladders:
1. Space siderails 18 inches apart unless otherwise indicated.
 2. Siderails: Continuous, steel flat bars, with eased edges. Refer to Drawings for sizes.
 3. Rungs: 3/4-inch- diameter, steel bars.
 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
 6. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
 7. Galvanize exterior ladders, including brackets.

8. Prime interior ladders, including brackets and fasteners, with zinc-rich primer. Paint exposed metal.

2.8 PERSONAL FALL ARREST DEVICES

- A. Personal Fall Arrest Devices; For ladders over 20 feet above finished grade, provide manufactured system consisting of pipe, channels or stainless steel cables designed to be secured to ladder. Include mounting brackets, and traveling devices for complete installed system.
 1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, include but are not limited to, the following:
 - a. FixFastUSA.
 - b. Granger Inc.
 - c. Industrial Safety Products.
 2. Pipe and channels shall be aluminum, galvanized steel or stainless steel

2.9 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.10 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 1. Hot-dip galvanize exterior steel fabrications exposed to weather.
 2. Hot-dip galvanize units after assembly.
 3. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion, unless otherwise indicated.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 1. Shop prime with primers specified in Section 099123 "Interior Painting" or Section 099113 "Exterior Painting," unless primers specified in Section 099600 "High-Performance Coatings" are indicated.
 2. Galvanized steel, including metallic-coated (galvanealed) steel, need not be shop primed, unless otherwise indicated. Clean as instructed by paint manufacturer prior to finishing.
- C. Preparation for Shop Priming: Prepare surfaces as specified in Section 099123 "Interior Painting," Section 099113 "Exterior Painting," or Section 099600 "High-Performance Coatings" to suit application indicated.
- D. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop priming.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- E. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M prior to painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports securely to, and rigidly brace from, building structure.

3.3 INSTALLATION OF METAL LADDERS

- A. Secure ladders to adjacent construction with the clip angles attached to the stringer.
- B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION

SECTION 055113 - METAL PAN STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial class steel stairs with concrete-filled landings and treads.
2. Architectural class steel stairs with precast concrete treads and landings.
3. Steel tube railings and guards attached to interior metal stairs.
4. Steel tube handrails attached to walls adjacent to interior metal stairs.
5. Railing gates at the level of exit discharge, as indicated or required.

B. Related Requirements:

1. Section 055213 "Pipe and Tube Railings" for exterior railings.
2. Section 099600 "High-Performance Coatings" for exposed steel finishes.

1.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs, railings, and guards.
1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, blocking for attachment of wall-mounted handrails, and items with integral anchors, that are to be embedded in concrete or masonry.
 2. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.
- D. Schedule installation of railings and guards so wall attachments are made only to completed walls.
1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.
5. Include railings and attachment to stairs and adjacent Work.
6. Include precast tread and landing profile details and details of attachment of precast units to steel framing.

B. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.

1. Include options for wall- and post- mounted handrail brackets for selection of type and material.
2. For precast concrete finish and color, if not providing basis-of-design product and finish indicated, provide manufacturer's standard color chips or charts for Architect's selection.

- C. Samples for Verification: Railings; for each type of exposed finish required, and the following.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish and treatment of welding.
 - 2. Fittings and brackets.
- D. Samples for Verification: Precast concrete units; for precast concrete finish and color; manufacturers standard size.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- C. Provide the following upon request:
 - 1. Welding certificates.
 - 2. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification.
 - 1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
 - 2. Protect steel members and packaged materials from corrosion and deterioration.
 - 3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.
 - a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load: 100 lbf/sq. ft..
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to $L/360$ or 1/2 inch, whichever is less.
- B. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
 3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- C. Seismic Performance of Stairs: Metal stairs withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Component Importance Factor: 1.5.

2.2 METALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing for Railings and Guards: ASTM A500/A500M (cold formed) or ASTM A513/A513M.
- D. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.
- E. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.
- F. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.3 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B633, and Class Fe/Zn 5 where built into exterior walls.
 1. Select fasteners for type, grade, and class required.
- B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated and capable of withstanding design loads.
- C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
- E. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

- A. Handrail Wall Brackets, Commercial Class: Cast iron, center of handrail 2-1/2 inches (79.4 mm) from face of railing to wall or post; type to be selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Blum, Julius & Co., Inc.
 - b. The Wagner Companies.
- B. Welding Electrodes: Comply with AWS requirements.
- C. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for interior use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.
- F. Prefilled Concrete Treads: Contractor's option for Commercial class stairs.
 - 1. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with minimum 28-day compressive strength of 3000 psi and maximum aggregate size of 1/2 inch unless otherwise indicated.
 - 2. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
 - 3. Plain Steel Welded-Wire Reinforcement: ASTM A1064/A10645M, galvanized steel, 6 by 6 inches, W1.4 by W1.4, unless otherwise indicated on Drawings.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 - 4. Reinforcement Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening welded-wire reinforcement in place.
 - a. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete.

2.5 PRECAST CONCRETE TREADS AND LANDINGS

- A. Precast Concrete Stair Treads and Landings (CONC-3): Precast concrete units cast in maximum lengths possible with full closed riser. Comply with manufacturer's written instructions for fabricating precast units in sizes and profiles indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bertelson Precast.
 - b. Empire Precast.
 - c. Stepstone LLC.
 - d. Wausau Tile (Basis-of-Design)
- B. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for Type III, normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 5000 psi and a total air content of not less than 6 percent or more than 8 percent with water-cement ratio of 0.45. Pigments used shall be inorganic, resistant to alkalinity and used per manufacturer's recommendations. Maximum deflection: L/720.

1. Finish: Wausau "Premium Ground and Polished"
 - a. Basis-of-Design Color: Wausau Misty Gray G33, or Architect approved equal by submitted manufacturer.
 2. Abrasive Inserts: A (13-mm-)lundum oxide/epoxy mix, silca sand/epoxy mix, or similar as standard for manufacturer.
 - a. Provide CBC-compliant inserts, solid or ribbed as standard with manufacturer with first insert located 1 inch (25 mm) from nosing at locations indicated on Drawings.
 - 1) Color: Contrasting in color selected by Architect.
 3. Platform Size and Weight Limitations: Eliminate joints in platform landings to greatest extent possible.
 - a. Where joints are unavoidable, provide only as shown on approved Shop Drawings; not more than 1/4 inch wide.
 - 1) Seal joints with manufacturer's recommended urethane joint sealant in accordance with Section 079200 "Joint Sealants" in color selected by Architect.
- C. Reinforcement: Galvanized, welded-wire reinforcement, 2 by 2 inches by 0.062-inch- diameter steel wire, unless otherwise provided by manufacturer; comply with ASTM A1064/A1064M, except for minimum wire size. Provide galvanized deformed rebar cages for longspan units as standard with manufacturer.
- D. Sizing Tolerances:
1. Units shall conform to approved Shop Drawings with a (+/-) 1/8 inch tolerance in dimension over 10 feet.
- E. Precast Surfaces and Edges:
1. Exposed edges shall have minimum of 1/8 inch radius to prevent chipping.
 2. Finished surfaces shall match approved control sample.
 3. Precast concrete finished surfaces shall be factory sealed.
 - a. Sealer: Colorless, pure acrylic water repellent sealer. Sealer to maintain natural look of concrete surface with no glaze or gloss, darkening or color change.

2.6 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings and guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
1. Join components by welding unless otherwise indicated.
 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings, and guards in shop to greatest extent possible.
1. Disassemble units only as necessary for shipping and handling limitations.
 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.

- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
 - 2. Locate joints where least conspicuous.

2.7 FABRICATION OF STEEL-FRAMED STAIRS - ARCHITECTURAL CLASS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.
- B. Stair Framing:
 - 1. Stringers: Fabricate of steel plates or steel channels or steel rectangular tubes as indicated on Drawings.
 - a. Stringer Size: As required to comply with "Performance Requirements" Article profiled as indicated on Drawings.
 - b. Provide closures for exposed ends of channel and rectangular tube stringers.
 - c. Exposed Finish: Painted according to Section 099600 "High-Performance Coatings."
 - 2. Platforms: Construct of steel plate or steel channel or steel rectangular tube headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.
 - a. Provide closures for exposed ends of channel and rectangular tube framing.
 - b. Exposed Finish: Painted according to Section 099600 "High-Performance Coatings."
 - 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
 - 4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below.
 - a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
- C. Precast Treads and Landings: Form treads with integral risers and landings to configurations shown.
 - 1. Directly weld tread and landing support angle brackets to stringers and platform framing.
 - a. Size angle brackets and, inserts and anchors to carry loads on treads and landings.
 - b. Smooth Soffit Construction: Provide flat metal or gypsum board under exposed soffit surfaces to produce smooth soffits as shown, concealing underside of stair framing and welds and brackets.
 - 2. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of welded joint.

2.8 FABRICATION OF STEEL-FRAMED STAIRS – COMMERCIAL CLASS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Commercial Class, unless more stringent requirements are indicated.
- B. Stair Framing:

1. Stringers: Fabricate of steel plates or steel channels or steel rectangular tubes as indicated on Drawings.
 - a. Stringer Size: As required to comply with "Performance Requirements" Article profiled as indicated on Drawings.
 - b. Provide closures for exposed ends of channel and rectangular tube stringers.
 - c. Exposed Finish: Painted according to Section 099600 "High-Performance Coatings."
 2. Platforms: Construct of steel plate or steel channel or steel rectangular tube headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.
 - a. Provide closures for exposed ends of channel and rectangular tube framing.
 - b. Exposed Finish: Painted according to Section 099600 "High-Performance Coatings."
 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
 4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below.
 - a. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
- C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch.
1. Steel Sheet, Uncoated: Hot-rolled steel sheet unless otherwise indicated.
 2. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
 3. Shape metal pans to include nosing integral with riser.
 4. At Contractor's option, provide stair assemblies with metal pan subtreads pre-filled with reinforced concrete during fabrication.
 5. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
 6. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish # 4 - Good quality, uniform undressed weld with minimal splatter.

2.9 FABRICATION OF STAIR RAILINGS AND GUARDS

- A. Architectural Class: Comply with applicable requirements in Section 057300 "Decorative Metal Railings."
- B. Commercial Class: Comply with the following.
 1. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.
 - a. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with cam-type, self-closing hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.
 2. Welded Connections: Fabricate railings and guards with welded connections.
 - a. Fabricate connections that are exposed to weather in a manner that excludes water.
 - b. Cope components at connections to provide close fit, or use fittings designed for this purpose.
 - c. Weld all around at connections, including at fittings.
 - d. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - e. Obtain fusion without undercut or overlap.
 - f. Remove flux immediately.
 - g. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" as follows:
 - 1) Commercial Class: Finish #2 - Completely sanded joint, some undercutting and pinholes are okay as shown in NAAMM AMP 521.

- C. Form changes in direction of railings and guards as follows:
 - 1. As detailed.
 - 2. By bending to smallest radius possible without causing deformation.
- D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- E. Close exposed ends of railing and guard members with prefabricated end fittings.
- F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.
- G. Connect posts to stair framing by direct welding unless otherwise indicated.
- H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
 - 1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
 - 2. For nongalvanized railings and guards, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves.
- I. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.
 - 1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.10 FINISHES

- A. Finish metal stairs after assembly.
- B. Preparation for Shop Priming: Prepare uncoated, ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
- D. Paint shop-primed metal stairs and railings as indicated in Section 099600 "High-Performance Coatings."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.
 - 1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL PAN STAIRS

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
 1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates.
 - a. Clean bottom surface of plates.
 - b. Set plates for structural members on wedges, shims, or setting nuts.
 - c. Tighten anchor bolts after supported members have been positioned and plumbed.
 - d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.
 - 1) Neatly finish exposed surfaces; protect grout and allow to cure.
 - 2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints.
 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 2. Do not weld, cut, or abrade surfaces of units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
 3. Comply with requirements for welding in "Fabrication, General" Article.
- F. Place and finish concrete fill for treads and platforms at Commercial Class stairs to comply with Section 033000 "Cast-in-Place Concrete."
- G. Install precast concrete treads and landings onto steel stair framing at Architectural Class stairs.
 1. Bolt precast concrete treads and landings through steel angles into threaded inserts according to precast manufacturer's written instructions and approved Shop Drawings.

3.3 INSTALLATION OF RAILINGS AND GUARDS

- A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.
 1. Space posts at spacing indicated or, if not indicated, as required by design loads.
 2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet.
 3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet.
 4. Secure posts, rail ends, and guard ends to building construction as follows:
 - a. Anchor posts to steel by welding to steel supporting members.
 - b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.
- B. Install railing gates level, plumb, and secure for full opening without interference.
 1. Attach hardware using tamper-resistant or concealed means.

2. Adjust hardware for smooth operation.
- C. Attach handrails to wall with wall brackets.
1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 2. Secure wall brackets to building construction as required to comply with performance requirements.

3.4 REPAIR

- A. Touchup Painting:
1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

END OF SECTION 055113

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Exterior galvanized steel railings.
- B. Related Requirements:
 - 1. Section 055113 "Metal Pan Stairs" for steel tube railings associated with interior Commercial class metal pan stairs.
 - 2. Section 057300 "Decorative Metal Railings" for ornamental railings attached to Architectural class stairs.
 - 3. Section 099600 "High-Performance Coatings" for exposed steel stair finishes.

1.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Include plans, elevations, sections, and details of metal railings, and attachments to other work.
- B. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes. Include options for wall- and post- mounted handrail brackets for selection of type.
- C. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish and treatment of welding.
 - 2. Fittings and brackets.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Provide the following upon request:
 - 1. Welding certificates.
 - 2. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
 - 3. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
 - 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt or with predrilled holes for exposed bolt anchorage and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

2.3 STEEL RAILINGS

- A. Tubing: ASTM A500/A500M (cold formed) ASTM A513/A513M, Type 5.
- B. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
- C. Plates, Shapes, and Bars: ASTM A36/A36M.
- D. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.4 FASTENERS

- A. Fastener Materials:
 - 1. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
 - 2. Finish exposed fasteners to match appearance, including color and texture, of railings.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.
- C. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
 - 1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) or Group 2 (A4) stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.5 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: Center of handrail 2-1/2 inches (79.4 mm) from face of railing to wall or post; type to be selected by Architect.
- B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
- C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated complying with Section 099600 "High-Performance Coatings."
- F. Intermediate Coats and Topcoats: Provide products that comply with Section 099600 "High-Performance Coatings."
- G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- H. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations where indicated on Drawings, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.

2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
 1. Provide weep holes where water may accumulate.
 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove flux immediately.
 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.
- I. Form changes in direction as follows:
 1. By bending to smallest radius that will not result in distortion of railing member.
- J. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 2. Coordinate anchorage devices with supporting structure.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
 2. Comply with ASTM A123/A123M for hot-dip galvanized railings.

3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
 4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows.
1. Comply with SSPC-SP 16.
- D. **High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.**
1. **Color: As selected by Architect from paint manufacturer's full range.**

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
1. Fit exposed connections together to form tight, hairline joints.
 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

- B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending 2 inches (50 mm) beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

- A. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with brackets on underside of rails connected to railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.
- C. Attach handrails to walls with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements, using self-tapping screws of size and type required to support structural loads, or use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.
- E. Install railing gates level, plumb, and secure for full opening without interference.
 - 1. Attach hardware using tamper-resistant or concealed means.
 - 2. Adjust hardware for smooth operation.

3.6 REPAIR

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099600 "High-Performance Coatings."

3.7 CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.8 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055213

SECTION 057300 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel picket decorative railings and handrails.
- B. Related Requirements:
 - 1. Division 05 Section "Pipe and Tube Railings" for interior back-of-house steel railings made from steel tubes.
 - 2. Division 09 Section "Non-Structural Metal Framing" for metal backing for anchoring railings.

1.2 DEFINITIONS

- A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas and for pedestrian guidance and support, visual separation, or wall protection.

1.3 COORDINATION AND SCHEDULING

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not meet structural performance requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufactured railing infill materials and related components.
 - 2. Grout and anchoring cement.
- B. Shop Drawings: Dimensioned drawings of railing assemblies. Include plans, elevations, sections, and attachment details. Show joint locations, transitions, and terminations. Provide Shop Drawings specific to this Project, complete with attachments and means of interface with other finish materials.
- C. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Welded connections.
 - 4. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

- B. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 24 inches in length.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Steel: 72 percent of minimum yield strength.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.
 - 1. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.

3. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.
4. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.

2.3 STEEL AND IRON

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Tubing: ASTM A500/A500M (cold formed) or ASTM A513.
- C. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.
- D. Plates, Shapes, and Bars: ASTM A36/A36M.

2.4 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 1. Uncoated Steel Components: Plated-steel fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed; Type 304 stainless steel fasteners where exposed.
 2. Dissimilar Metals: Type 304 stainless steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193.
 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- D. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; no evidence of a welded joint.
- I. Form changes in direction as follows:
 - 1. As detailed.
- J. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Close exposed ends of hollow railing members with prefabricated end fittings.
- L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.
- N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- O. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

2.7 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.8 STEEL FINISHES

- A. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves.
- B. Steel Railings: Shop prime and paint according to section 099600 "High-Performance Coatings."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.
- B. Examine cast-in-place concrete assemblies and locate existing reinforcing to verify that locations of drilled anchorages for supporting handrails will not conflict with reinforcing. Where conflicts are encountered, obtain concurrence of structural engineer of record prior to proceeding.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
 - 4. Align wall mounted handrails so variations in distance to supporting wall do not exceed 1/4 inch in between successive support brackets. Shim brackets as required.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

- A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, or leave anchorage joint exposed, as indicated on Drawings.
- D. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
 - 2. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry as indicated on Drawings and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections, as indicated on Drawings.
- C. Attach handrails to walls with wall brackets except where end flanges are used. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
- D. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

2. For steel-framed partitions, screw fastened to steel backing as indicated on Drawings. Coordinate with stud installation to locate backing members.

3.6 CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

3.7 REPAIR

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

3.8 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 057300

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wood blocking, cants, and nailers.
 - 2. Wood furring and grounds.
 - 3. Plywood backing panels.

- B. Related Requirements:
 - 1. Section 061600 "Sheathing" for exterior sheathing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
 - 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

- B. Provide the following upon request:
 - 1. Evaluation Reports: For the following, from ICC-ES:
 - a. Preservative-treated wood.
 - b. Fire-retardant-treated wood.
 - c. Power-driven fasteners.
 - d. Post-installed anchors.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.
2. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
3. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841. For enclosed roof framing, framing in attic spaces, and where high-temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
- E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat items indicated on Drawings, and the following:
 1. Concealed blocking.
 2. Roof framing and blocking.
 3. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
 4. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
 3. Rooftop equipment bases and support curbs.
 4. Cants.
 5. Furring.
- B. Dimension Lumber Items: Construction or No. 2 Standard, Stud, or No. 3 grade lumber of any species. any of the following species: the following species:
 1. Hem-fir (north); NLGA.
 2. Mixed southern pine or southern pine; SPIB.
 3. Spruce-pine-fir; NLGA.
 4. Hem-fir; WCLIB or WWPA.
 5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
 6. Western woods; WCLIB or WWPA.
 7. Northern species; NLGA.
- C. Concealed Boards: 15 percent maximum moisture content of any of the following the following species and grades:
 1. Mixed southern pine or southern pine, No. 3 grade; SPIB.
 2. Hem-fir or hem-fir (north), Standard or No. 3 Common grade; NLGA, WCLIB, or WWPA.
 3. Spruce-pine-fir (south) or spruce-pine-fir, Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
 4. Northern species, No. 3 Common grade; NLGA.
 5. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Screws for Fastening to Metal Framing: ASTM C1002, length as recommended by screw manufacturer for material being fastened.
- D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
 - 2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

2.7 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Do not splice structural members between supports unless otherwise indicated.

- E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- F. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- G. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- H. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- I. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. CBC Table 2304.10.1, "Fastening Schedule."
 - 2. ICC-ES evaluation report for fastener.
- J. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 INSTALLATION OF WOOD FURRING

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- size furring horizontally at 24 inches o.c.
- C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal- size furring vertically at 16 inches o.c.

3.4 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Exterior glass-mat wall sheathing.
 - 2. Cement board sheathing.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for plywood backing panels.

1.2 ACTION SUBMITTALS

- A. Product Data Submittals: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
- B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.
 - 1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
 - 2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 3. Include details of interfaces with other materials that form part of air barrier.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WALL SHEATHING

- A. Glass-Mat Gypsum Sheathing, Walls: ASTM C1177/C1177M.
 - 1. Products:Manufacturers Subject to compliance with requirements, provide one of the following:
 - a. Certainteed; SAINT-GOBAIN; GlasRoc.
 - b. Georgia-Pacific Gypsum LLC.; Dens-Deck Gold
 - c. National Gypsum; Gold Bond e(2)XP
 - d. USG Corporation; Securock..
 - 2. Type and Thickness: Type X, 5/8 inch thick.
- B. Cementitious Backer Units: ASTM C1325, Type A.

1. DUROCK Cement Board as manufactured by USG Corporation, or comparable by one of the following:
 - a. C-Cure.
 - b. Custom Building Products.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or Type 304 stainless steel.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
 1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
 2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

2.4 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Refer to Section 072726 "Fluid-Applied Membrane Air Barriers" for treatment of joints and penetrations in glass-mat gypsum sheathing.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 1. California Building Code, Table 2304.10.1, "Fastening Schedule."
 2. ICC-ES evaluation report for fastener.
- D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 INSTALLATION OF GYPSUM SHEATHING

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to framing with screws.
 - 2. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
 - 3. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
 - 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
 - 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
 - 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
 - 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- E. Seal sheathing joints in accordance with sheathing manufacturer's written instructions and Section 072726 "Fluid-Applied Membrane Air Barriers".

END OF SECTION 061600

SECTION 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-clad architectural cabinets.
 - 2. Cabinet hardware and accessories.
 - 3. Miscellaneous materials.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.

1.2 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.3 DEFINITIONS

- A. Definitions in the AWI Glossary apply to the Work of this Section.

1.4 ACTION SUBMITTALS

- A. Product Data Submittals: For each product.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Show large-scale details.
 - 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
- C. Samples for Initial Selection: For each type of exposed finish requiring selection by Architect.
- D. Samples for Verification: For the following:
 - 1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
 - a. Provide one sample applied to core material with specified edge material applied to one edge.
 - 2. Thermally Fused Laminate (TFL) Panels: 8 by 10 inches, for each color, pattern, and surface finish.
 - a. Provide edge banding on one edge.
 - 3. Corner Pieces:
 - a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
 - 4. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.5 CLOSEOUT SUBMITTALS

- A. Quality Standard Compliance Certificates: AWI Quality Certification Program or WI Certified Compliance Program certificates indicating compliance with requirements for fabrication and installation.
- B. Final Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.

1.6 QUALITY ASSURANCE

- A. Fabricator's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of products or installer approved by fabricator. or Installer approved by fabricator.
- C. Provide the following upon request:
 - 1. Qualification Data: For Fabricator and Installer, if not fabricator.
 - 2. Product Certificates: For the following:
 - a. Composite wood products.
 - b. Thermally fused laminate panels.
 - c. High-pressure decorative laminate.
 - d. Adhesives.
 - 3. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with the AWI 200 - Care & Storage for delivery, storage, and handling of architectural woodwork.
- B. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- C. Deliver interior architectural woodwork materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.8 FIELD CONDITIONS

- A. General: Comply with the AWI 200 - Care & Storage for environmental control and acclimation requirements for storage and installation of architectural woodwork.
- B. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until adjacent work in space is thoroughly protected, wet work is nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- C. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until adjacent work in space is thoroughly protected, wet work is nominally dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.

- D. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- E. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

- A. Quality Standard: Unless otherwise indicated, with the "Architectural Woodwork Institute - ANSI/AWI Standards" for grades of cabinets indicated for construction, finishes, installation, and other requirements. Standards indicated refer to the ANSI/AWI Standards as required to achieve certification from the AWI Quality Certification Program. Use of the Architectural Woodwork Standards (AWS, current edition) is an acceptable alternative to achieve approval from the WI Certified Compliance Program.
 - 1. Provide inspections by AWI or WI certification program inspectors of fabrication and installation indicating that woodwork complies with requirements of grades specified.
 - a. Provide certificates from AWI or WI certification program at Closeout indicating that woodwork fabrication and installation has been inspected and complies with requirements of grades specified.
 - 2. The Contract Documents contain selections chosen from options in the quality standard and may include additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard. If a conflict arises, provide the more stringent requirement.
 - 3. Contractor or fabricator shall register the Work under this Section with AWI's Quality Certification Program or WI's Certified Compliance Program, as applicable.
 - 4. AWI Standards include the following as applicable to each individual Specification Section:
 - a. AWI 100 - Submittals
 - b. AWI 200 - Care and Storage
 - c. AWI 300 - Materials
 - d. ANSI/AWI 0400 - factory Finishing
 - e. ANSI/AWI 0620 - Finish Carpentry/installation
 - f. ANSI/AWI 0641 - Architectural Wood Casework
- B. Regional Materials: Wood products shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
- C. Certified Wood: Wood products shall comply with requirements of ASTM D7612-10 (FSC, SFI, ATSM, CSA or PEFC certifications are acceptable).

2.2 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. AWI Standards Grades: According to ANSI/AWI 0641-2019 - Architectural Wood Casework Standard.
 - 1. Aesthetic Grade: Custom
 - 2. Performance Duty: 3
- B. Type of Construction: Frameless.

- C. Door and Drawer-Front Style: Flush overlay.
- D. High-Pressure Decorative Laminate: ISO 4586-3, grades as indicated or if not indicated, as required by quality standard.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABET Inc.
 - b. Formica Corporation.
 - c. Laminart LLC.
 - d. Pionite; a Panolam Industries International, Inc. brand.
 - e. Wilsonart LLC.
 - 2. Basis-of-Design Products: As indicated on Drawings .
- E. Exposed Surfaces:
 - 1. Plastic-Laminate Grade: HGS.
 - 2. Edges: PVC tape, 0.018-inch minimum thickness, matching laminate in color, pattern, and finish.
- F. Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: Thermally fused laminate panels.
 - a. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.
 - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, ISO 4586-3, grade to match exposed surface.
 - 2. Drawer Sides and Backs: Thermally fused laminate panels with PVC or polyester edge banding.
 - 3. Drawer Bottoms: Thermally fused laminate panels.
- G. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, ISO 4583-3, grade to match exposed surface.
- I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.
- J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. As indicated by laminate manufacturer's designations.

2.3 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
2. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
3. Particleboard (Medium Density): ANSI A208.1, Grade M-2-Exterior Glue.
4. Softwood Plywood: DOC PS 1, medium-density overlay.
5. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of ISO 4586.

2.4 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.
1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.
- C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less in accordance with ASTM E84.
1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
 2. For panels 13/16 to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf, respectively.
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Arauco North America.
 - b. Timber Products, Inc.

- D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less in accordance with ASTM E84.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Roseburg.

2.5 CABINET HARDWARE AND ACCESSORIES

- A. Cabinet Hardware: Provide cabinet hardware and accessory materials associated with architectural cabinets.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Accuride International Inc.
 - b. CompX International, Inc.
 - c. Grass America.
 - d. Hardware Resources.
 - e. Hettich America L.P.
 - f. Julius Blum & Co., Inc.
 - g. Knappe & Vogt Manufacturing Company.
 - h. Sugatsune.
- B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, minimum 110 degrees of opening, self-closing.
- C. Pulls:
 - 1. Edge Pulls: Refer to Drawings.
- D. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.
- E. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.
- F. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Standard Duty (Grade 1 and Grade 2): Side mount.
 - 2. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): Side mount.
 - a. Type: Full overtravel extension.
 - b. Material: Epoxy-coated polymer slides.
 - c. Motion Feature: Soft close dampener and self-closing mechanism.
 - 3. Pencil drawers not more than 3 inches high and not more than 24 inches wide, provide 50 lb load capacity.
 - 4. General-purpose drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide 75 lb load capacity.
 - 5. File drawers more than 6 inches high or more than 24 inches wide, provide 100 lb load capacity.
 - 6. Lateral file drawers more than 6 inches high and more than 24 inches but not more than 30 inches wide, provide 150 lb load capacity.
 - 7. Lateral file drawers more than 6 inches high and more than 30 inches wide, provide 200 lb load capacity.
 - 8. Computer keyboard tray, provide 75 lb load capacity.
- G. Door Locks: ANSI/BHMA A156.11, E07121.
- H. Drawer Locks: ANSI/BHMA A156.11, E07041.

- I. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- J. Grommets for Cable Passage: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - 1. Color: To be selected by Architect.
- K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated. To be selected by Architect
- L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.6 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Metal Backing and Reinforcement: Refer to Section 092216 "Non-Structural Metal Framing."
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- D. Adhesives: Do not use adhesives that contain urea formaldehyde.
- E. Adhesive for Bonding Plastic Laminate: Type I, waterproof or Type II water-resistant type as selected by fabricator to comply with requirements.
 - 1. Adhesive for Bonding Edges: Adhesive specified above for faces, except use hot-melt adhesive in wet areas.

2.7 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
 - 2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- D. When cabinets abut side walls, allow for a 1 inch filler panel between side of cabinet and wall. For floor mounted cabinets the filler panel is to include a toe kick to match casework.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. AWI Standards Grade: Install cabinets to comply with quality standard grade of item to be installed in accordance with ANSI/AWI 0620-2018 - Finish Carpentry/Installation or Architectural Woodwork Standards as applicable to casework.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish or toggle bolts through metal backing or metal framing behind wall finish.

3.3 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program or WI's Certified Compliance Program certifying that woodwork, including installation, complies with requirements of the ANSI/AWI Standards or Architectural Woodwork Standards for the specified grade.
 - 1. Inspection entity shall prepare and submit certificates of inspection at Closeout.

3.4 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION 064116

SECTION 066400 - PLASTIC PANELING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fiber-reinforced-plastic (FRP) sheet paneling.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For plastic paneling and trim accessories, in manufacturer's standard sizes.

1.3 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain plastic paneling and trim accessories from single manufacturer.

2.2 PLASTIC SHEET PANELING

- A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D5319.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Composites, Inc.
 - b. Marlite.
 - c. Nudo Products, Inc.
 - 2. Basis-of-Design Products: As indicated; refer to Finish Schedule on Drawings.

2.3 ACCESSORIES

- A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
 - 1. Color: Match panels.
- B. Adhesive: As recommended by plastic paneling manufacturer.
- C. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- B. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.
- C. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- D. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels.
 - 1. Mark plumb lines on substrate at trim accessory locations for accurate installation.
 - 2. Locate trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Install trim accessories with adhesive.
- D. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.
- E. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- F. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
- G. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 066400

SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Modified bituminous sheet waterproofing.
 2. Blindsight sheet waterproofing.
 3. Molded-sheet drainage panels.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, adhesion to contaminated substrate (e.g. concrete curing compounds and form release agents), substrate curing period weather related restrictions during installation, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs. Include the following:
 - a. Before starting application of membrane waterproofing work, arrange a job-site meeting with the Architect, the Testing Agency and manufacturer representative to discuss the following:
 - 1) The waterproofing system, number of plies, termination and flashing requirements.
 - 2) Intermediate and final requirements of protecting the work.
 - 3) The different substrates that will receive the waterproofing and preparation requirements for each.
 - 4) Curing requirements for concrete.
 - 5) Concrete form release agent precautions.
 - 6) Verify admixtures and compatibility with waterproofing manufacturer.
 - 7) Adhering to coated surfaces, if applicable.
 - 8) Job specific recommendations on use of primers.
 - 9) Hot, cold and wet condition precautions.
 - 10) Scheduling and coordination with other construction, such as waterproofing overlaps that must be installed during construction of walls and footings both above and below grade.
 - 11) Protection of the work and repair procedures.
 - 12) Verify in writing to the Owner's representative, that the Contractor's full time on site foreman and crew etc. (as required) are certified, or meet the requirements of the manufacturer of the waterproofing, as installers.
 - b. Whenever the membrane waterproofing work is to be done, notify Testing Agency in sufficient time to arrange inspections.
 - c. Provide safe access to the location of the Work for proper inspection.
 - d. Post installation testing (e.g. Flood Testing or Electronic Field Vector Mapping.)

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

- C. Samples: For each exposed product and for each color and texture specified, including the following products:
 - 1. 8-by-8-inch square of waterproofing and flashing sheet.
 - 2. 4-by-4-inch square of drainage panel.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.
- B. Provide the following upon request:
 - 1. Qualification Data: For Installer.
 - 2. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
 - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.
- C. Compatibility:
 - 1. Where new work interfaces existing waterproofed construction, remove existing waterproofing as required to install new work. Interface new waterproofing with existing system to provide continuous system without leaks. Ensure compatibility of system materials.
 - 2. The waterproofing manufacturer shall submit a letter stating compatibility or concerns with existing, or adjacent, waterproofing.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard materials-only warranty in which manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Blindside Sheet Waterproofing Manufacturer's Warranty: Manufacturer's material and labor warranty in which manufacturer agrees to cover labor and to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
 - 1. Warranty Period: Fifteen years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Modified Bituminous Sheet: Minimum 60-mil nominal thickness, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated on one side to a 4-mil-thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer that complies with VOC limits of authorities having jurisdiction.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. GCP Applied Technologies Inc.; Bituthene 4000
 2. Physical Properties:
 - a. Tensile Strength, Membrane: 250 psi minimum; ASTM D 412, Die C, modified.
 - b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
 - c. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D 1970.
 - d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
 - e. Puncture Resistance: 40 lbf minimum; ASTM E 154.
 - f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.
 - g. Water Vapor Permeance: 0.05 perms maximum; ASTM E 96/E 96M, Water Method.
 - h. Hydrostatic-Head Resistance: 200 feet minimum; ASTM D 5385.

2.3 BLINDSIDE SHEET WATERPROOFING

- A. Adhesive-Coated HDPE Sheet for Blindside Vertical Applications: Uniform, flexible, multilayered-composite sheet membrane consisting of an HDPE film coated with a pressure-sensitive adhesive and protective release liner, total 32-mil thickness; with the following physical properties:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. GCP Applied Technologies; Preprufe 160R Plus.
 2. Physical Properties:
 - a. Tensile Strength, Film: 4000 psi minimum; ASTM D 412.
 - b. Low-Temperature Flexibility: Pass at minus 10 deg F; ASTM D 1970.
 - c. Peel Adhesion to Concrete: 5 lbf/in. minimum; ASTM D 903, modified.
 - d. Lap Adhesion: 2.5 lbf/in. minimum; ASTM D 1876, modified.
 - e. Hydrostatic-Head Resistance: 231 feet; ASTM D 5385, modified.
 - f. Puncture Resistance: 100 lbf minimum; ASTM E 154.
 - g. Water Vapor Permeance: 0.01 perms maximum; ASTM E 96/E 96M, Water Method.
 - h. Water Absorption: 0.5 percent maximum; ASTM D 570.
- B. Adhesive-Coated HDPE Sheet for Blindside Horizontal Applications: Uniform, flexible, multilayered-composite sheet membrane consisting of an HDPE film coated with pressure-sensitive adhesive and protective release liner, total 46-mil thickness; with the following physical properties:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. GCP Applied Technologies Inc.; Preprufe 300R Plus.
 2. Physical Properties:
 - a. Tensile Strength, Film: 4000 psi minimum; ASTM D 412.
 - b. Low-Temperature Flexibility: Pass at minus 10 deg F; ASTM D 1970.
 - c. Peel Adhesion to Concrete: 5 lbf/in. minimum; ASTM D 903, modified.
 - d. Lap Adhesion: 2.5 lbf/in. minimum; ASTM D 1876, modified.
 - e. Hydrostatic-Head Resistance: 231 feet; ASTM D 5385, modified.
 - f. Puncture Resistance: 200 lbf minimum; ASTM E 154.

- g. Water Vapor Permeance: 0.01 perms maximum; ASTM E 96/E 96M, Water Method.
- h. Water Absorption: 0.5 percent maximum; ASTM D 570.

2.4 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
 - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid primer recommended for substrate by sheet-waterproofing material manufacturer.
 - 1. Product: GCP Adhesive Primer B2 LVC by GCP Applied Technologies.
- C. Primer for Positive-Side Modified Bituminous Sheet Membrane Vertical Application:
 - 1. Product: Bituthene Primer B2 LVC by GCP Applied Technologies.
- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.
 - 1. Bituthene Liquid Membrane by GCP Applied Technologies.
- E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating and compatible with waterproofing assembly.
- F. Waterproofing Tape:
 - 1. Waterproofing Tape (4 in. wide): Preprufe Tape LT (for temperatures between 25 degrees F (minus 4 degrees C) and 86 degrees F (plus 30 degrees C)) and Preprufe Tape HC (for use in Hot Climates, minimum 50 degrees F).
 - 2. Construction Joint Tape (8 in. wide) for covering cut edges, roll ends, penetrations, terminations, and repairs: Preprufe CJ Tape, by GCP Applied Technologies.
 - 3. Detail Tape (2 in. wide)
- G. Sheet Strips: Self-adhering, rubberized-asphalt sheet strips of same material and thickness as sheet waterproofing.
- H. Mastic and Adhesives: Liquid mastic and adhesives recommended by waterproofing manufacturer.
 - 1. Mastic: Rubberized asphaltic mastic adhesive provided by, or as approved by, membrane manufacturer:
 - a. Product: GCP Bituthene Mastic
- I. Expansion Joints: Proprietary field fabricated expansion joints shall be used with manufacturers waterproofing or as recommended by the waterproofing manufacturer, unless stated otherwise.
- J. Metal Termination Bars:
 - 1. Termination Bar: Stainless Steel 1 inch by 8 feet, 0.075" thick, with 5/16" holes 8" to 9" on center.
 - a. Product: Advanced Building Products Inc. Stainless Steel Termination Bar, or equal.
 - 2. Expansion Anchor: 1/4" x 2" expansion anchor consisting of a Type 304 Stainless Steel drive pin and an expanding body. Basis of design: Hilti Metal HIT Anchor.
- K. Protection Course:
 - 1. Protection Board Vertical Applications: Extruded polystyrene board insulation, Type IV, 25 psi minimum compressive resistance, shiplap edged.
 - a. Products: Subject to compliance with requirements, provide the following:
 - 1) Extruded Polystyrene; Kingspan GreenGuard; Type 4 Insulation Board.

- b. Adhesive: 3M; Scotch-Weld.
- L. Reinforced Fluid Applied Flashing: Manufacturer's recommended to suit conditions.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. GCP; Bithuthene Liquid Membrane.
 - b. GCP; Preprufe Liquid Flashing
- M. Self-Adhering Stainless Steel Flexible Flashing:
 - 1. Subject to compliance with requirements, provide the following:
 - a. York Manufacturing Inc.; York 304 or 316 SA
 - 2. Characteristics:
 - a. Type: stainless steel with one stainless steel face (facing outward) with a butyl block co-polymer adhesive (inward facing).
 - b. Stainless steel: type 304 or 316, ASTM A240. Domestically sourced per DF ARS 252.225-7008 and/or DF ARS 252.225-7009.
- N. Sealants, Cleaners, Adhesives, and similar items: Provide as recommended by waterproofing membrane manufacturer.

2.5 MOLDED-SHEET DRAINAGE PANELS

- A. Type 1: Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate of 9 to 18 gpm per ft..
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. GCP Applied Technologies Inc.; Hydroduct 220 (vertical).
 - 2. Include outlet pipe connectors, connector tees, corner guards and detail tape for complete drainage assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the waterproofing.
 - 1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D 4263.
- B. Examine membrane, with Installer present, before and after the installation of steel reinforcement. All damage should be documented and repaired prior to the installation of concrete in accordance with the manufacturer's written instruction or as modified herein.
- C. Condition of Surfaces: Surfaces to receive membrane shall be free of defects or conditions that will interfere with or prevent a satisfactory installation of waterproofing systems.

1. Provide a smooth, sound, and continuous surface. The maximum surface roughness for concrete substrates shall be equivalent to ICRI CSP 5 or smoother.
 2. Substrate can be damp but must not have any liquid water that can transfer to a dry hand upon contact.
- D. Contaminants: Surfaces shall be thoroughly cleaned and shall be free of water, dew, frost, dust, dirt, oil, grease, concrete curing compounds, laitance, and other foreign matter.
- E. Other Work: Installation of other work passing through or concealed by waterproofing shall be complete and approved before starting work of membrane installation.
- F. Do not install waterproofing in standing water.
- G. Surfaces to receive Liquid Membrane must be dry, without any appearance of dampness.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrates in accordance with manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D 4258.
1. Install sheet strips of width in accordance with manufacturer's written instructions and center over treated construction and contraction joints and cracks.
- F. Bridge and cover isolation joints and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths in accordance with manufacturer's written instructions.
- G. Corners: Prepare, prime, and treat inside and outside corners in accordance with ASTM D 6135.
1. Install membrane strips centered over vertical inside corners. Install 3/4-inch fillets of liquid membrane on horizontal inside corners and as follows:
 - a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions in accordance with ASTM D 6135.

3.3 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

- A. Install modified bituminous sheets in accordance with waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. General

1. Application of all waterproofing systems shall be sequenced with other trades.
2. Waterproofing systems shall be installed to provide a monolithic, watertight system.
3. Comply with waterproofing manufacturer's installation instructions and product recommendations unless more stringent requirements are specified herein.
4. Sheet membrane laps shall be placed to shed water.

D. Apply and firmly adhere sheets, 100% back rolled, over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.

1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.

E. One-Ply Application: Install sheets to form a membrane with lap widths of a uniform 2-1/2-inch minimum.

1. For one ply application, install 6" wide Sheet Strips over all laps.

F. Two-Ply Application, where hydrostatic head is present, as follows:

1. Install first ply; install sheets to form a membrane with lap widths of a uniform 2-1/2-inch minimum.
2. Install second ply; install sheets to form a membrane with lap widths of a uniform 2-1/2-inch minimum.
3. Stagger seams of first ply and second ply. Do not align seams of first ply with second ply.

G. Horizontal Application: Install Two-Ply Application, apply sheets from low to high points of decks to ensure that laps shed water. Only install liquid membrane over seams to the top layer.

H. Corners: Prepare, prime, and treat positive side inside and outside corners according to ASTM D6135.

1. Apply 1 inch cant of Liquid Membrane at all inside corners.
2. Apply 6 inch wide reinforcing strip of modified bituminous sheet membrane at all inside and outside corners. Roll membrane firmly with steel hand roller.

I. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

J. Seal edges of sheet-waterproofing terminations with mastic.

K. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.

1. Terminate membrane with a termination bar, fastened 6 in. on center. Fully encapsulate the leading edge of the membrane waterproofing, termination bar, and fasteners with liquid membrane.

L. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches beyond repaired areas in all directions.

M. Immediately install protection course with butted joints over waterproofing membrane.

3.4 BLINDSIDE SHEET-WATERPROOFING APPLICATION

A. Install bonded blindside sheet waterproofing in accordance with manufacturer's written instructions.

B. Place and secure molded-sheet drainage panels over substrate. Lap edges and ends of geotextile to maintain continuity.

- C. Vertical Applications: Install sheet with face against substrate. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by membrane manufacturer. Overlap and seal seams, and stagger and tape end laps to ensure watertight installation. Mechanically fasten to substrate.
 - 1. Securely fasten top termination of membrane with continuous metal termination bar anchored into substrate and cover with detailing tape.
- D. Horizontal Applications: Install sheet with face against substrate. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by membrane manufacturer. Overlap and seal seams, and stagger and tape end laps to ensure watertight installation.
- E. Corners: Seal lapped terminations and cut edges of sheet waterproofing at inside and outside corners with detail tape.
- F. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.
- G. Install sheet-waterproofing and auxiliary materials to produce a continuous watertight tie into adjacent waterproofing.
 - 1. Do not use plastic or metal chairs to support rebar against the membrane.
- H. Penetrations, Construction Joints, and Damage:
 - 1. All penetrations shall be sealed in accordance with the manufacturer's instructions and details.
- I. Repairs: Repair tears, punctures, air blisters, excessively dirty membrane, and inadequately lapped seams, in accordance with the manufacturer's instructions, except as modified below, before the concrete is poured.

3.5 MOLDED-SHEET DRAINAGE-PANEL INSTALLATION

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, in accordance with manufacturer's written instructions. Use adhesives or other methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. For vertical applications, install protection course before installing drainage panels.
- B. When the vertical drainage panel is installed, the flange should be facing the direction opposite of the perimeter drain panel water flow. When the drainage panel is installed horizontally, the edge of the core with the flange should be at the top. This flange position, similar to roof shingle applications, shall minimize seepage of water behind the drain. Fold back the fabric at the top of the perimeter drainage panel and place the vertical drainage panel on top of the perimeter drainage panel core flange. Fold fabric from sheet drain section down over the perimeter drainage panel section and secure with 3 in. tape.
- C. Continue installing additional rolls of drainage panels as instructed by manufacturer.
- D. Seal all edges. Edges of drainage panels shall have extra fabric tucked behind core edge seal to prevent soil from entering core.
- E. Soil should be placed and compacted directly against the drain. Use care during backfill operation to avoid damage to the waterproofing system. Follow generally accepted practices for backfill compacted in 6 inch to 12 inch lifts to avoid stresses on the waterproofing system. Direct compactor exhaust away from the drain to prevent damage. Backfill to a minimum of 6 inches above drain to allow for coverage after settlement.

3.6 FIELD QUALITY CONTROL

- A. Site Representative: Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish daily reports to Architect.
- B. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, waterproofing application, protection, and drainage components, and to furnish reports to Architect.
- C. Post Installation Testing: All waterproofed surfaces.
 - 1. Electric Field Vector Mapping (EFVM): EFVM technician shall survey entire waterproofing area for potential leaks using EFVM.
 - a. Install a temporary leak detection system by one of the following or approved equal:
 - 1) International Leak Detection, Ltd, Ontario, Canada.
 - 2) Honza Group Incorporated, Columbia, Maryland.
 - b. Engage a company experienced in detecting breaches in the waterproofing using an electronic detection system.
 - c. If breaches are discovered, repair the breach and retest the affected area. Repeat this process until no breach is detected.
 - 2. Engage an independent testing agency to observe testing. If breaches are discovered, the independent testing agency shall observe repairs and retesting of discovered breaches.
 - 3. Prepare test reports upon completion of flood testing. Submit to Architect upon request.

3.7 PROTECTION, REPAIR, AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Protect installed insulation from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. When waterproofing materials are subjected to damage by sunlight and cannot be immediately protected as specified, protect the waterproofing materials by waterproof building paper or suitable coating recommended by the manufacturer of the waterproofing system used.
- E. Rejection of Damaged Work:
 - 1. Damaged materials or work will be rejected.
 - 2. Rejected materials or work must be immediately removed and replaced with new materials.
 - 3. Repairs or replacement of damaged work shall be provided at no added costs to the owner.
- F. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- G. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 071800 - TRAFFIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes preparation of substrates and application of traffic coatings for the following applications:
 - 1. Pedestrian traffic on exterior stairs (CONC-#).
- B. Related Requirements:
 - 1. Section 096723 "Resinous Flooring" for fluid-applied, interior, decorative resinous flooring with integral wearing surface.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Notify participants at least 5 working days before conference.
 - 1. Prior to commencement of the fluid application waterproofing system, meet at the site with a representative of the coating manufacturer, Contractor, Architect, District representative, and other parties affected by this Section.
 - 2. Review methods and procedures related to pedestrian traffic coating system installation, including Contract Documents and manufacturer's written instructions.
 - 3. Examine deck substrate conditions and finishes for compliance with requirements.
 - 4. Review loading limitations of deck.
 - 5. Review flashings, special details, deck drainage, penetrations, curbs, and condition of other construction that will affect pedestrian traffic coating.
 - 6. Review governing regulations and requirements for insurance, certifications, and inspection and testing, if applicable.
 - 7. Review temporary protection requirements for pedestrian traffic coating system during and after installation.
 - 8. Review protection for building residents and property.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including installation instructions.
- B. Shop Drawings: For traffic coatings.
 - 1. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.
 - 2. Include plans showing layout of pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Samples for Initial Selection: For each type of exposed finish; manufacturer's standard size chips.
- D. Samples for Verification: For each exposed product and each type of exposed finish, for each color and texture selected, prepared on rigid backing.
 - 1. Provide stepped Samples on backing to illustrate buildup of traffic coatings.

1.4 INFORMATIONAL SUBMITTALS

- A. Certification: Submit current "Qualified Applicator" certificate from the manufacturer.
- B. Sample Warranties: Sample copies of manufacturer and Contractor warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For traffic coatings to include in maintenance manuals.
- B. Final coating warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to perform Work of this Section who has specialized in installing pedestrian traffic coatings similar to that required for this Project; who is approved, authorized, or licensed by the system manufacturer to install manufacturer's product; and who is eligible to receive the standard manufacturer's warranty.
- B. Primary waterproofing materials shall be products of a single manufacturer. Secondary materials shall be recommended by the primary manufacturer. Manufacturer shall have a minimum of 10 years experience in the manufacture of materials of this type.
- C. Applicators shall have a minimum of 5 years experience in the application of waterproofing materials of the type specified. Applicator shall possess a current "Qualified Applicator" certificate from the specified waterproofing manufacturer.
- D. Provide the following upon request:
 - 1. Qualification Data: For Installer.
 - 2. Product Certificates: For each type of traffic coating.
 - 3. Field-quality control test and inspection reports.
- E. Mockups: Build mockups to verify selections made under submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation..
 - 1. Build mockup for each traffic coating and substrate to receive traffic coatings.
 - 2. Size: Provide a minimum of two standalone stair treads of same size as permanent treads to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship.
 - 3. Perform slip-resistance testing on mockup according to requirements in Field Quality Control Article. If flooring does not pass testing, remediate according to resinous flooring manufacturer's instructions until floors pass testing. Apply remediation procedures to final installation.
 - 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.
 - 1. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.
- B. Do not install traffic coating until items that penetrate membrane have been installed.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace and compensate for labor for failures in traffic coating materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:

- a. Adhesive or cohesive failures.
 - b. Abrasion or tearing failures.
 - c. Surface crazing or spalling.
 - d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.
2. Warranty Period: 10 years from date of Substantial Completion.
- B. Installer's Warranty: Installer agrees to repair or replace traffic coating at no cost to the District for failures due to workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Adhesive or cohesive failures.
 - b. Abrasion or tearing failures.
 - c. Surface crazing or spalling.
 - d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.
 2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Dynamic Coefficient of Friction: Provide resinous flooring with dynamic coefficient of friction indicated as determined by testing identical products per ANSI A137.1/A326.3 DCOF AcuTest procedure.
1. Dynamic Coefficient of Friction (DCOF):
 - a. Stairs, intermittent/slippery wet: Not less than 0.50 wet.

2.2 MATERIALS, GENERAL

- A. Material Compatibility: Provide primers; base-, intermediate-, and topcoat; and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Source Limitations:
1. Obtain traffic coatings from single source from single manufacturer.
 2. Obtain primary traffic-coating materials, including primers, from traffic-coating manufacturer. Obtain accessory materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of types and from sources recommended in writing by primary material manufacturer.
- C. Traffic Coating: Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, waterproofing membrane system with integral wearing surface for concrete substrates according to ASTM C 957.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle Coatings & Waterproofing Inc.
 - b. Dudick Inc.
 - c. Gaco Western.
 - d. Key Resin Company.
 - e. Neogard.
 - f. Pacific Polymers; ITW Polymers Sealants North America.
 - g. Tremco Incorporated.

2.3 TRAFFIC COATING (CONC-2)

- A. Material: Urethane, for application indicated.

- B. Use and Application: Pedestrian, exterior; for use on stair treads.
- C. Preparatory and Base Coats: Apply base coat per manufacturer's written instructions.
 - 1. Thickness: Minimum dry film thickness 20 mils.
- D. Wear/Top Coat: Apply wear/top coat per manufacturer's written instructions (liquid membrane and aggregate) and back roll to encapsulate aggregate into liquid membrane.
 - 1. Thickness: Minimum dry film thickness 12 mils, measured excluding aggregate.
 - 2. Color: As selected by Architect from manufacturer's full range.
 - 3. UV inhibitors: Use UV inhibitors when traffic coating is exposed to direct sunlight, as recommended by the traffic coating manufacturer.
- E. Aggregate: Manufacturer's standard aggregate for each use indicated of particle sizes, shape, and minimum hardness recommended in writing by traffic coating manufacturer.

2.4 MATERIAL PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Provide traffic-coating materials with the fire-test-response characteristics as determined by testing identical products per test method below for deck type and slopes indicated by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction.
 - 1. Class A roof covering per ASTM E 108 or UL 790.
- B. VOC Content 100 g/L or less.
 - 1. Low-Emitting Materials: Verify interior coatings comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 ACCESSORY MATERIALS

- A. Primer: Liquid waterborne solvent-borne primer recommended for substrate and conditions by traffic-coating manufacturer.
- B. Joint Sealants: As specified in Section 079200 "Joint Sealants."
- C. Sheet Flashing: Nonstaining sheet material recommended in writing by traffic-coating manufacturer.
- D. Adhesive: Contact adhesive recommended in writing by traffic-coating manufacturer.
- E. Reinforcing Strip: Fiberglass or polyester fabric mesh recommended in writing by traffic-coating manufacturer.
- F. Sealers: Material recommended in writing by traffic-coating manufacturer.
- G. Slip-Resistant granules: Granule: Hard (90 Rockwell Scale) non-crushable, non-extractable, organic granule with a specific gravity of 1.3 and size of 18/40 or other micromedia as recommended by coating manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of traffic-coating work.
- B. Verify that substrates are visibly dry and free of moisture.
 - 1. Moisture Testing: Test for moisture content by method recommended in writing by traffic-coating manufacturer. At a minimum, do not apply primer or coating until concrete stair treads meet one of the following minimum requirements as instructed by traffic-coating manufacturer:
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - 2. If water moisture tests exceed stated limits, apply vapor retarder for moisture vapor emission control as specified in Section 090561.13.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of traffic-coating work.
- D. Proceed with installation only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.
 - 1. Begin coating application only after minimum concrete-curing and -drying period recommended in writing by traffic-coating manufacturer has passed and after substrates are dry, but not less than 28 days after initial pour.
 - 2. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. General: Before applying traffic coatings, clean and prepare substrates in accordance with ASTM C 1127 and manufacturer's written instructions to produce clean, dust-free, dry substrate for traffic-coating application. Remove projections, fill voids, and seal joints if any, as recommended in writing by traffic-coating manufacturer.
- B. Schedule preparation work so dust and other contaminants from process do not fall on wet, newly coated surfaces.
- C. Mask adjoining surfaces not receiving traffic coatings to prevent overspray, spillage, leaking, and migration of coatings. Prevent traffic-coating materials from entering deck substrate penetrations and clogging weep holes and drains.
- D. Concrete Substrates: Mechanically abrade surface to a uniform profile acceptable to manufacturer, in accordance with ASTM D 4259. Do not acid etch.
 - 1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
 - 2. Remove concrete fins, ridges, and other projections.
 - 3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
 - 4. Remove remaining loose material to provide a sound surface, and clean surfaces in accordance with ASTM D 4258.

- E. Concrete shall have hardened sufficiently to prevent excess fine material from working to the surface prior to finishing. Concrete substrates shall have a slightly sand-textured surface. The end result shall be neither slick nor burnished, nor shall contain voids or rock pockets.

3.3 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions and recommendations.
- B. Coordinate with the manufacturer and provide the Work required by the manufacturer for the specified warranty.

3.4 TERMINATIONS AND PENETRATIONS

- A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves in accordance with ASTM C 1127 and manufacturer's written instructions.
- B. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.
- C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
- D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates in accordance with manufacturer's written recommendations.

3.5 JOINT AND CRACK TREATMENT

- A. Prepare, treat, rout, and fill joints and cracks in substrates in accordance with ASTM C 1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D 4258.
 - 1. Comply with recommendations in ASTM C 1193 for joint-sealant installation.
- B. Apply reinforcing strip in traffic-coating system where recommended in writing by traffic-coating manufacturer.

3.6 TRAFFIC-COATING APPLICATION

- A. Apply traffic coating in accordance with ASTM C 1127 and manufacturer's written instructions.
- B. Apply the specified compositions for each type of traffic coating at locations as indicated on Drawings.
- C. Start traffic-coating application in presence of manufacturer's technical representative.
- D. Verify that wet film thickness of each coat complies with requirements every 100 sq. ft..
- E. Apply primer, flashing and reinforcing strips in accordance with manufacturer's written instructions
- F. Uniformly broadcast aggregate on coats specified to receive aggregate. Embed aggregate per system type and in accordance with manufacturer's written instructions.
- G. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces where traffic coating terminates beyond four inches up the wall.
- H. Cure traffic coatings. Prevent contamination and damage during application and curing stages.
- I. Apply sealers and slip-resistant granules according to manufacturer's instructions.

3.7 FIELD QUALITY CONTROL

- A. Slip Resistance: Engage special testing agency to perform the following tests.
1. Dynamic Coefficient of Friction (DCOF): A reading of not less than indicated for each wet/dry area indicated in Performance Requirements above shall be achieved and documented, as determined by a certified NFSI walkway auditor using the ANSI A137.1/A326.3 quality control test using a recognized tribometer.
 - a. Test mockup and once for each three stair treads.
- B. Final Traffic-Coating Inspection: Arrange for traffic-coating manufacturer's technical personnel to inspect membrane installation on completion.
1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- C. Field-Adhesion Testing: Perform field pull testing on traffic coating adhesion to substrates as follows:
1. Extent of Testing: Test completed and cured cold fluid-applied waterproofing as follows:
 - a. Perform tests so installation follows directly after pull tests. Tests require overnight cure time.
 - b. Perform 2 tests for each location and each substrate.
 - c. Perform tests where and as required by the waterproofing consultant or manufacturer.
 - d. Retest if there are weather variations that affect installation of waterproofing.
 2. Test Method:
 - a. Prepare substrates as intended for project-specific waterproofing installation at each test location. Install primer and sealer on substrates indicated to receive primer and sealer. Allow primer and sealer to cure. Perform pull test after primer and sealer has cured. Perform another pull test 24 hours after initial pull test.
 - b. Apply cold fluid-applied waterproofing to specified mil thickness with half of 4 inch x 12 inch transition reinforcing fabric fully embedded in waterproofing membrane so 4 inches x 6 inches of reinforcing fabric is not embedded in the waterproofing membrane. Allow cold fluid-applied waterproofing to cure.
 - c. Pull reinforcement 90 degrees from plane of installed waterproofing. Pull slowly, trying not to tear reinforcement.
 3. Inspect tested waterproofing and report on the following:
 - a. Temperature, humidity and other weather conditions that affect installation of the waterproofing
 - b. Whether coating dimensions and configurations comply with specified requirements.
 - c. Whether coating connected to pulled-out portion failed to adhere to substrates or tore cohesively. Compare these results to determine if adhesion passes manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when coating was installed, names of persons who installed the products, test dates, test locations, whether substrate was primed, adhesion results and installation dimensions.
 5. Remove coating from substrate following pull tests. Ensure that original surfaces are clean.
 6. Coordinate pull tests with Architect, and District. Notify all parties 48 hours in advance of pull tests.
- D. Evaluation of Field-Adhesion Test Results: Traffic coatings that fails cohesively within itself, not evidencing adhesive failure from testing or noncompliance with other indicated requirements and meets manufacturer's requirements will be considered satisfactory. Remove waterproofing that fails to adhere to substrates during testing or to comply with other requirements. Retest failed applications until test results prove waterproofing complies with indicated requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports. Submit to Architect upon request.

3.8 PROTECTING AND CLEANING

- A. Protect traffic coatings from damage and wear during remainder of construction period.

- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Polyisocyanurate foam-plastic board insulation.
 - 2. Glass-fiber blanket insulation.
 - 3. Mineral-wool batt/blanket insulation.
 - 4. Insulation fasteners and accessories.

- B. Related Requirements:
 - 1. Section 075419 "Polyvinyl-Chloride (PVC) Roofing" for insulation specified as part of roofing construction.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
 - 1. Sign, date, and post the certification in a conspicuous location on Project site.

- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

- C. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project site in their original containers or packages or bundles bearing label clearly identifying manufacturer's name, brand, grade, UL listing, and other pertinent information.

- B. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

- A. Foil-Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 or Class 2; thickness and width indicated and manufacturer's standard length as required to suit job conditions; with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84 manufactured with non-halogenated fire-retardants.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Atlas Roofing Corporation.
 - b. Carlisle Coatings & Waterproofing Inc.
 - c. DuPont.

- d. Firestone Building Products.
 - e. Hunter Panels.
 - f. Johns Manville.
 - g. Rmax, Inc.
2. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.2 MINERAL-WOOL BATT/BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Fibrex Insulations Inc.
 2. Johns Manville.
 3. Rockwool International.
 4. Thermafiber.
- B. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; thickness as indicated with width and length as required to suit job conditions; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 1. Minimum density of 0.6 lbs. per cubic foot.
 2. Minimum thermal resistivity (R) of 3.1deg F x h x sq. ft./Btu x in. at mean temperature of 75 degrees F.
 3. Thermal Resistance: Of total thickness required to provide a minimum thermal resistance of R4.3 per inch (deg. F.h.sf/Btu).
 4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.3 GLASS-FIBER BATT/BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. CertainTeed Corporation.
 2. Johns Manville.
 3. Knauf Insulation.
 4. Owens Corning.
- B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; thickness as indicated with width and length as required to suit job conditions; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 1. Thermal Resistance: Refer to Drawings for total thermal resistance of exterior walls..
 2. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.4 INSULATION FASTENERS

- A. Mechanically Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
 - b. Gemco; Spindle Type.
 2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

- B. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
 - b. Gemco; Spindle Type.
 2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch diameter; length to suit depth of insulation indicated.
- C. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Gemco; 90-Degree Insulation Hangers.
 2. Angle: Formed from 0.030-inch-thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch diameter; length to suit depth of insulation indicated.
- D. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGM Industries, Inc.; RC150.
 - b. Gemco; Dome-Cap R-150.
 2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Crawl spaces.
 - b. Ceiling plenums.
 - c. Attic spaces.
 - d. Where indicated.
- E. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch 2 inches 3 inches between face of insulation and substrate to which anchor is attached.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Gemco; Clutch Clip.
- F. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, air barrier, fasteners, and substrates. When in contact with air barrier, provide adhesive and chemical compatible material that is acceptable by the air barrier manufacturer.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGM Industries, Inc.
 - b. Gemco.
 2. Adhesion Strength: 15 lbf/sq. in. minimum.

2.5 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Unfaced, Mineral-Wool Blanket Insulation.
 - 2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
 - 1. Adhesives shall have a VOC content of 70 g/L or less.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
- D. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF CONTINUOUS BOARD INSULATION

- A. Polyisocyanurate Board Insulation: Friction fit insulation between Z-girts and other subframing components, and mechanically attach impaling pin through exterior sheathing into steel stud or adhere to substrate with daubs of adhesive spaced approximately 12 inches on center. Fit insulation with edges butted tightly in both directions. Fit insulation tightly around cladding attachments and other obstructions. Space impaling pins per manufacturer to resist the weight of the insulation board and wind load; press units onto impaling pins and set firmly against exterior surface of wall and install locking washer onto impaling pin.
 - 1. Butter all edges of insulation board with adhesive or fill joints with spray foam sealant.
 - 2. Fill all voids with spray foam sealant.
- B. Ensure insulation is tightly fitted with sides of insulation slightly compressed at each insulation spacer. Ensure insulation pieces are in contact with no linear gaps between girts or other subframing. Install system to fill-in exterior spaces without gaps or voids. Do not compress insulation panels.
- C. Trim insulation neatly to fit spaces, and insulate miscellaneous gaps and voids.

- D. Fit insulation with edges butted tightly. Fit insulation tightly between thermal spacers and around cladding attachments, penetrations, and other obstructions. Fill voids with spray-applied polyurethane foam sealant.
- E. Ensure and verify permanent retention of continuous insulation prior to installing exterior cladding systems.

3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Glass-Fiber Batt/Blanket Insulation: Install in cavities formed by framing members in accordance with the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members and/or building construction with no gaps or voids.
 - 3. Secure insulation blankets to framing members with fasteners as recommended by the insulation manufacturer.
 - 4. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 - a. Provide galvanized metal furring or metal bands or wire lacing as required to hold insulation blankets in place without sagging.
- C. Mineral-Wool Batt/Blanket Insulation: Install in cavities formed by framing members in accordance with the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members and/or building construction with no gaps or voids.
 - 3. Secure insulation blankets to framing members with fasteners as recommended by the insulation manufacturer.
 - 4. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 5. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 - 6. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 - a. Provide galvanized metal furring or metal bands or wire lacing as required to hold insulation blankets in place without sagging.
- D. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.
- E. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials, matching adjacent insulation type where possible:
 - 1. Unfaced glass-fiber blanket insulation. ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
 - 2. Spray Polyurethane Insulation: Apply in accordance with manufacturer's written instructions.

3.5 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 072713 - MODIFIED BITUMINOUS SHEET AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes self-adhering, vapor-retarding, modified bituminous sheet air barriers if required for patching and repairing to match existing exterior assemblies.
- B. Related Requirements:
 - 1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
 - 2. Section 072726 "Fluid-Applied Membrane Air Barriers" for air barriers used in new construction and if required for matching existing assemblies.

1.2 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.
 - 1. Submit letter from primary materials manufacturer indicating approval of products not manufactured by primary manufacturer.
 - 2. Include certification statement from air-barrier manufacturer, certifying permanent chemical and adhesive compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier, and certifying that cleaning materials used during installation are chemically compatible with each of the adjacent materials proposed for use.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. A qualified firm that is approved, authorized, or licensed by the manufacturer to install manufacturer's product, that is eligible to receive manufacturer's special warranty, and is experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Submit the following upon request:
 - 1. Qualification Data: For Installer.

- a. Provide evidence from the manufacturer that the firm is approved, authorized, or licensed to install the specified products and is eligible to receive manufacturer's special warranty.
 - b. Provide evidence that the installing firm is experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
2. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
 1. Protect substrates from environmental conditions that affect air-barrier performance.
 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

1.8 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard product warranty, for a minimum 10 years from date of Substantial Completion.
- B. Special Installer's Warranty: Provide air barrier installer's 2 year warranty from date of Substantial Completion, including all components of the air barrier assembly, against failures including loss of air tight seal, loss of watertight seal, loss of adhesion, loss of cohesion, failure to cure properly.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- B. VOC Content: 250 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing and/or dampproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested in accordance with ASTM E 2357.

- C. Provide an air barrier assembly that withstands combined positive and negative design wind, fan and stack pressures on the envelope without damage or displacement, that transfers the load to the structure, and that does not displace adjacent materials under full load. Join air barrier system materials in an airtight and flexible manner to adjacent assemblies, allowing for the relative movement of assemblies due to thermal and moisture variations and creep, and anticipated seismic movement.

2.3 SELF-ADHERING SHEET AIR BARRIER

- A. Modified Bituminous Sheet: 40-mil- thick, self-adhering sheet consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick, cross-laminated polyethylene film with release liner on adhesive side and formulated for application with primer that complies with VOC limits of authorities having jurisdiction.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. GCP Applied Technologies Inc.; Perm-A-Barrier Wall Membrane.
 - b. Henry Company; Blueskin SA.
 - c. Tremco Incorporated, an RPM company; ExoAir 110.
 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
 - b. Tensile Strength: Minimum 250 psi; ASTM D 412, Die C.
 - c. Ultimate Elongation: Minimum 200 percent; ASTM D 412, Die C.
 - d. Puncture Resistance: Minimum 40 lbf; ASTM E 154.
 - e. Water Absorption: Maximum 0.15 percent weight gain after 48-hour immersion at 70 deg F; ASTM D 570.
 - f. Vapor Permeance: Maximum 0.05 perm; ASTM E 96/E 96M, Water Method.

2.4 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier membrane.
- B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.
- C. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.
- D. Transition Membrane: Between Air Barrier Membrane and Other Adjacent Materials: Comply with both air barrier manufacturer's recommendations and adjacent material manufacturer's recommendations.
1. Liquid Flashing: Manufacturer's standard trowel grade liquid flashing.
 - a. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.
 2. Butyl Strip: 30 to 40 mils thick, self-adhering; polyethylene-film-reinforced top surface laminated to layer of butyl adhesive with release liner backing.
 3. High Temperature Modified Bituminous Strip: 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
 - a. For use under metal copings and flashings directly exposed to the exterior.
 4. Foil Faced Modified Bituminous Strip: 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
 5. Modified Bituminous Strip: 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
 6. Adhesive-Coated Transition Strip: Vapor-permeable, 17-mil- thick, self-adhering strip consisting of an adhesive coating over a permeable laminate with a permeance value of 37 perms.
 7. Elastomeric Flashing Sheet: ASTM D 2000, 2BC415 to 3BC620, minimum 50- to 65-mil- thick, cured sheet neoprene with manufacturer-recommended contact adhesives and lap sealant with stainless-steel termination bars and fasteners.

8. Preformed Silicone-Sealant Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.
 - a. Dow Corning Corporation; Silicone Transition Strip System.
 - b. Momentive Performance Materials Inc.; US11000 UltraSpan.
 - c. Tremco Incorporated; Proglaze ETA Connections.
9. Self-Adhering Stainless Steel Flexible Flashing:
 - a. Subject to compliance with requirements, provide the following:
 - 1) York Manufacturing Inc.; York 304 SA.
 - b. Characteristics:
 - 1) Type: Stainless steel with one stainless steel face (facing outwards) with a butyl block co-polymer adhesive (inward facing).
 - 2) Stainless Steel: Type 304, ASTM A240. Domestically sourced per DF ARS 252.225-7008 and/or DF ARS 252.225-7009.
- E. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
- F. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0187 inch thick, and Series 300 stainless-steel fasteners.
- G. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft. density; flame-spread index of 25 or less in accordance with ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.
- H. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 079200 "Joint Sealants."
- I. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 2. Verify that existing concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method in accordance with ASTM D 4263 or as required by the sheet air barrier manufacturer to verify concrete is acceptable for installation of air barrier.
- B. Manufacturer's Field Services: Engage manufacturer's qualified technical representative to review substrates prior to installation of sheet air barrier patches to determine compliance with requirements. Perform adhesion tests as needed to ensure compliance. Manufacturer shall submit certification of substrate inspection along with any preparation or remediation requirements to produce sound substrate for adhesion.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate in accordance with manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.

- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from existing concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in existing concrete with substrate-patching membrane.
- E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- F. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.
- G. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D 4258.
 - 1. Install modified bituminous strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.
- H. Bridge and cover isolation joints discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with overlapping transition membranes.

3.3 TRANSITION MEMBRANE INSTALLATION

- A. General: Install transition membrane and accessory materials in accordance with air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane, below grade waterproofing, and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install manufacturer's recommended transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 - 1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials as recommended by manufacturer.
- D. At end of each working day, seal top edge of transition membrane to substrate with termination mastic.
- E. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition membrane so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact.
 - 1. Modified Bituminous Transition Strip: Roll firmly to enhance adhesion.

2. Adhesive-Coated Transition Strip: Roll firmly to enhance adhesion.
 3. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
 4. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- H. Seal transition membrane around masonry reinforcing or ties and penetrations with termination mastic.
- I. Seal top of through-wall flashings to air barrier with an additional 6-inch- wide, transition membrane.
- J. Seal exposed edges of transition membrane at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- K. Repair punctures, voids, and deficient lapped seams in transition membrane. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.4 SELF-ADHERING SHEET AIR BARRIER INSTALLATION

- A. General: Install modified bituminous sheets and accessory materials in accordance with air-barrier manufacturer's written instructions and in accordance with recommendations in ASTM D 6135. Apply only when patching and repairing existing compatible sheet air barriers.
1. When ambient and substrate temperatures , install self-adhering, modified bituminous air-barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than .
- B. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for longer than allowed by manufacturer, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane in accordance with air-barrier manufacturer's written instructions.
 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fluid-applied, vapor-permeable membrane air barriers including all components for a complete weather-resistant installation, that incorporates the ABAA Quality Assurance Program (QAP).
 - 1. Work includes furnishing and installation of materials to bridge and seal air and water leakage pathways where installed including, but not limited to, roof and foundation junctions, window and door openings, control and expansion joints, piping and other penetrations through the wall assembly.
- B. Related Requirements:
 - 1. Section 061600 "Sheathing" for wall sheathings.
 - 2. Section 079200 "Joint Sealants;" for procedural, administrative, product and execution requirements for sealants specified in this Section.

1.2 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.
- D. Weather Barrier: The term weather barrier shall be used interchangeably with fluid-applied water/air barrier including all components.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Include installers of other construction connecting to air barrier, including roofing, dampproofing, sealants, , storefronts, and door frames.
 - 2. Review air barrier requirements including surface preparation, substrate condition and pretreatment, minimum substrate curing period, forecasted weather conditions, special details and sheet flashings, mockups, installation procedures, sequence of installation, testing and inspecting procedures, materials approved for use, compatibility of materials, coordination with installation of adjacent and covering materials, and protection and repairs.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of air barrier.
 - 1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.
 - 2. Submit letter from primary materials manufacturer indicating approval of products not manufactured by primary manufacturer.
 - 3. Include statement that materials are compatible with adjacent materials proposed for use and the following.

- a. For materials that the air barrier system will bond to, provide letters as necessary from each manufacturer confirming materials and substrates for the air barrier system is chemically and adhesively compatible with the air barrier system and the bonded to material.
 - b. For materials that are proposed to bond to the air barrier system, provide letters as necessary from each manufacturer confirming materials proposed to bond to the air barrier system are chemically and adhesively compatible with the air barrier system.
4. Submit reports indicating that field peel-adhesion test on all materials to which sealants are adhered have been performed and the changes made, if required, to other approved materials, in order to achieve successful adhesion.

B. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air barrier. Include project specific details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
2. Indicate total area (sq. ft.) of air barrier to be installed.
3. Include project specific details of interfaces with other materials that form part of the air barrier.
4. Include letter from manufacturer indicating that the project specific details and shop drawings have been reviewed and are approved for use.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by the Installer, who work on Project and the following:

1. Provide evidence from the manufacturer that the firm is approved, authorized, or licensed to install the specified products and is eligible to receive manufacturer's special warranty.
2. Provide evidence that the installing firm is experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
3. Provide a manual that describes Installers and Manufacturers Quality Assurance / Quality Control program and procedures.
4. Sample of Installers Daily Work Sheet.

B. Product Certificates: From air-barrier manufacturer, certifying permanent chemical and adhesive compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier, and certifying that cleaning materials used during installation are chemically compatible with each of the adjacent materials proposed for use.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

D. Evaluation Reports: Manufacturer's ICC evaluation report confirming compliance with the CBC and IECC as an air barrier and water-resistive barrier.

E. Sample Warranty: Sample each type of warranty from Manufacturer and Installer.

F. Installation Reports: Provide Installer Daily Worksheet for project record. Provide reports weekly to Architect for each week installation of air barrier system occurs.

G. Field Test Results: Submit mockup and in-situ test results of air leakage test and water leakage test with specified standards, including retesting if initial results are not satisfactory.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer shall have minimum 5 years of local application experience with specified weather barriers or similar installations.

2. Employ skilled mechanics who are experienced and knowledgeable in waterproofing and air barrier application, and familiar with the requirements of the specified work.
 3. A qualified firm that is approved, authorized, or licensed by the manufacturer to install manufacturer's product, that is eligible to receive manufacturer's special warranty, and is experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
 4. A firm that is an ABAA-licensed contractor and employs certified and registered installers.
 5. A firm that complies with ABAA's Quality Assurance Program.
 6. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- B. **Manufacturer Qualifications:** A qualified manufacturer of exterior air barrier membrane and component materials for a minimum of 10 years in North America regularly engaged in manufacturing air barrier membranes.
- C. **Mockups:** Before beginning installation of air barrier, build first-in-place mockups to set quality standards for materials and execution and for preconstruction testing.
1. Build mockups of exterior wall assembly , 150 sq. ft., incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection by District's testing agency of air barrier before external insulation and cladding are installed.
 - b. Include junction with roofing vapor retarder, building corner condition, and below-grade waterproofing where applicable.
 - c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

- A. **Preconstruction Testing Service:** District will engage a qualified testing agency to perform preconstruction testing on field mockups.
- B. **Mockup Testing:** Air-barrier assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
1. **Water Spray Test:** Areas designated by the Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
 - a. Perform tests at transitions to adjacent exterior enclosure assemblies, deflection joints, and expansion joints.
 - b. Perform tests at a representative sample of each condition.
 - c. **Water Penetration Failure Criteria:**
 - 1) Water leakage to the interior of the building is a failure.
 - 2) Water observed on interior surfaces of the system is a failure.
 - 3) Water observed on interior surfaces of adjacent systems, originating from the wall system or the transition to the adjacent systems, is a failure.
 - d. Provide an inspection report that indicates results.
 2. **Adhesion Testing:** Mockups will be tested for minimum air-barrier adhesion of 16 lbf/sq. in. or to manufacturer's minimum adhesion level per substrates, whichever is greater, according to ABAA T0002. Perform test after curing period recommended by the manufacturer. Record mode of failure and area which failed in accordance with referenced standard.

- a. Test Locations: Perform 1 test per substrate type. (Each test site includes 3 pull tests)
 - b. Provide an inspection report that indicates results.
3. Wet Film Thickness Test (to be performed by installer at time of installation and included on ABAA QAP daily worksheet):
- a. Test material using wet film gauge to confirm that membrane meets manufacturer's indicated wet film thickness requirements.
 - b. Minimum one per coat per substrate type.
 - c. Failure Criteria:
 - 1) A measurement less than manufacturer's required wet film thickness is considered a failure.
 - d. Provide an inspection report indicating results and include photo documentation.
4. Dry Film Thickness Test:
- a. Test material in accordance with manufacturer's requirements to confirm that cured membrane meets manufacturer's indicated dry film thickness requirements.
 - b. Three 1 inch x 4 inch samples removed from separate areas with gypsum facer intact to avoid stretching membrane.
 - c. Failure Criteria:
 - 1) A measurement less than manufacturer's required dry film thickness is considered a failure.
 - d. Provide an inspection report indicating results and include photo documentation.
5. Air barriers will be considered defective if they do not pass tests and inspections.
- a. Wet Film Thickness: Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 - b. Upon failure of Dry Film Testing or Adhesion Testing:
 - 1) Determine cause of failure.
 - 2) Provide one additional test for each occurrence of failure on the mockup.
 - 3) Repair deficient air barrier components per manufacturer's recommendations.
 - 4) Repair tested areas per manufacturer's recommendations.
 - c. Upon failure of water spray testing:
 - 1) Determine cause of failure.
 - 2) Repair per manufacturer's recommendations and retest deficient air barrier components.
6. Notify Architect 14 days in advance of the dates and times when mockups will be tested.
7. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
8. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in their original sealed containers bearing manufacturer's name and identification of product.
- B. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- C. Protect stored materials from direct sunlight.
- D. Protect coatings from freezing temperatures and temperatures in excess of 90 degrees F.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
 - 1. Protect substrates from environmental conditions that affect air-barrier performance.
 - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

1.10 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard product warranty covering labor and materials for defects in workmanship for weather barriers, including all components, for a minimum 10 years from date of Substantial Completion.
- B. Special Installer's Warranty: Provide air barrier installer's 2 year warranty from date of Substantial Completion, including all components of the air barrier assembly, against failures including loss of air tight seal, loss of watertight seal, loss of adhesion, loss of cohesion, failure to cure properly.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary materials and air-barrier accessories from single source manufacturer to achieve specified warranty. Additional accessory products are acceptable for use provided they are approved by the primary air barrier manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-retarding permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed dampproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at a pressure differential of 1.57 psf (75 Pa) when tested in accordance with ASTM E 2357, including materials, penetrations and connections.
- C. Membrane Air Leakage: Air permeance not to exceed 0.004 cfm/sq. ft. of surface area at a pressure differential of 1.57 psf (75 Pa) when tested in accordance with ASTM E 2178.
- D. Provide an air barrier assembly that withstands combined positive and negative design wind, fan and stack pressures on the envelope without damage or displacement, that transfers the load to the structure, and that does not displace adjacent materials under full load. Join air barrier system materials in an airtight and flexible manner to adjacent assemblies, allowing for the relative movement of assemblies due to thermal and moisture variations and creep, and anticipated seismic movement.

2.3 VAPOR-PERMEABLE MEMBRANE AIR-BARRIER

- A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier:
 - 1. Silicone Based Technology Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corp.; Defend Air 200.
 - b. Momentive Performance Materials; Elemax 2600 AWB.

2. STPE Based Technology Products: Subject to compliance with requirements, provide one of the following:
 - a. DuPont; Tyvek Fluid Applied WB +.
3. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
 - b. Vapor Permeance: Minimum 10 perms; ASTM E 96/E 96M.
 - c. Ultimate Elongation: Minimum 200 percent; ASTM D 412, Die C.
 - d. Structural-Test Performance: Test according to ASTM E 330 or ASTM E1233 at a positive or negative pressure of 30psf.
 - 1) No cracking within the field of the panel, substrate joints and at interface of flashing.
 - e. Water Penetration under Static Pressure: No evidence of water penetration through the air barrier assembly when tested according to ASTM E 331 at a minimum static-air-pressure differential of 6.24 lbf/sq.ft..
 - 1) Water Penetration: Water leakage to the interior of the building is a failure. Water observed on interior surfaces of the system or adjacent wall systems is a failure.

2.4 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.
- B. Transition Membrane: Between Air Barrier Membrane and Other Adjacent Materials: Comply with both air barrier manufacturer's recommendations and adjacent material manufacturer's recommendations.
 1. Fluid-Applied Flashing: Manufacturer's standard trowel grade liquid flashing.
 - a. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.
 2. High Temperature Modified Bituminous Strip: 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
 - a. For use under metal copings and flashings directly exposed to the exterior.
 3. Foil Faced Modified Bituminous Strip: 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
 4. Preformed Silicone-Sealant Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.
 - a. Dow Corning Corporation; Silicone Transition Strip System.
 - b. Momentive Performance Materials Inc.; US11000 UltraSpan.
 - c. Tremco Incorporated; Proglaze ETA Connections.
 5. Self-Adhering Stainless Steel Flexible Flashing:
 - a. Subject to compliance with requirements, provide the following:
 - 1) York Manufacturing Inc.; York 304.
 - b. Characteristics:
 - 1) Type: Stainless steel with one stainless steel face (facing outwards) with a butyl block co-polymer adhesive (inward facing).
 - 2) Stainless Steel: Type 304, ASTM A240. Domestically sourced per DF ARS 252.225-7008 and/or DF ARS 252.225-7009.
- C. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.

- D. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.
- E. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
- F. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0187 inch thick, and Series 300 stainless-steel fasteners.
- G. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft density; flame-spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.
- H. Joint Sealants: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 079200 "Joint Sealants."
- I. CMU Block Filler: Manufacturer's standard filler.
- J. Concrete Filler: Manufacturer's standard filler.
- K. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.
- L. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchor spacing of 9" on center minimum unless otherwise required by the manufacturer. Provide galvanized sheet metal backup plate at locations where adequate substrate is not available for securing the termination bar.
- M. Provide galvanized sheet metal backup plate at locations where adequate substrate is not available for securing the cladding accessories and attachments, flashings, and termination bars.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Provide verification in writing from the air-barrier manufacturer that concrete has cured and aged for minimum time period required by air-barrier manufacturer.
 - 3. Verify that concrete is visibly dry and free of moisture.
 - 4. Perform moisture testing as required by air-barrier manufacturer for test type, rate, and quantity to validate that substrate is acceptable, dry, and free of moisture.
 - 5. Verify that the minimum concrete drying period recommended by air barrier system manufacturer has passed. Perform moisture content testing as required by the air barrier system manufacturer to verify concrete is acceptable for installation of air barrier.
 - 6. Verify that masonry joints are flush and completely filled with mortar.
 - 7. Verify sealants used in sheathing are compatible with membrane proposed for use. Perform field peel-adhesion test on materials to which sealants are adhered.
 - 8. Verify that metal strapping has been installed where required for securing accessories such as termination bars and flashings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

3.3 JOINT TREATMENT

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
 - 1. Prime substrate and apply air-barrier manufacturer's recommended thickness, number of coats, and reinforcement extending a minimum of 3 inches along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.
- B. Gypsum Sheathing: Fill joints greater than 1/4 inch with sealant according to ASTM C 1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

3.4 TRANSITION MEMBRANE INSTALLATION

- A. General: Install transition membrane and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane, below grade waterproofing, and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install manufacturer's recommended transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 - 1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials as recommended by manufacturer.

- D. At end of each working day, seal top edge of transition membrane to substrate with termination mastic.
- E. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition membrane so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing surface.
 - 1. Provide fluid-applied membranes for manufacturer's that offer it as part of the air barrier system.
 - 2. For manufacturers that do not offer a liquid flashing, use transition membrane method that is acceptable to the air barrier manufacturer and that is chemically and adhesively compatible with the adjacent construction.
 - a. Self-Adhering Stainless Steel Flexible Flashing Transition Strip: Roll firmly to enhance adhesion.
 - b. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material. Tool sealant along edges of extrusion.
- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- H. Seal transition membrane around masonry reinforcing or ties and penetrations with termination mastic.
- I. Seal top of through-wall flashings to air barrier with an additional 6-inch- wide, transition membrane.
- J. Seal exposed edges of transition membrane at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- K. Repair punctures, voids, and deficient lapped seams in transition membrane. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

- A. General: Apply fluid air-barrier material to form a seal with transition membrane and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.
 - 1. Apply primer to substrates at required rate and allow it to dry.
 - 2. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 - 3. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats as recommended by the manufacturer and as needed to achieve required bond, with adequate drying time between coats.
- B. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
 - 1. Apply to a total wet film thickness as required by the membrane manufacturer to meet the performance requirements indicated.
- C. Apply transition membrane according to air-barrier manufacturer's written instructions.
- D. Provide air barrier and accessories that are acceptable for use at horizontal surfaces without detrimental effects to material.
- E. For exterior cladding and veneer attachment devices and accessories such as clips, thermal breaks, brick ties, flashings, stone/metal coping fasteners, and metal panel anchors:

1. Set device in a full bed of sealant after air barrier is cured.
2. Seal over fastener heads after device is secured.
3. Seal top edge of accessories installed in the horizontal orientation.

F. Do not cover air barrier until it has been tested and inspected by District's testing agency.

G. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: District will engage a qualified testing agency to perform tests and inspections.

B. District's Inspection and Testing: Cooperate with District's testing agency. Allow access to work areas and staging. Notify District's testing agency in writing of schedule for Work of this Section to allow sufficient time for testing and inspection. Daily inspection and testing may be required. Do not cover Work of this Section until testing and inspection is accepted.

C. Periodic Inspections: Provide for air barrier system manufacturer's technical personnel to inspect installation weekly during periods of ongoing installation.

D. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Air-barrier dry film thickness.
3. Air-barrier wet film thickness (to be performed by installer at time of installation and included on daily worksheet).
4. Continuous structural support of air-barrier system has been provided.
5. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
6. Site conditions for application temperature and dryness of substrates have been maintained.
7. Maximum exposure time of materials to UV deterioration has not been exceeded.
8. Surfaces have been primed, if applicable.
9. Laps in transition membranes have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
10. Termination mastic has been applied on cut edges.
11. Transition membranes are firmly adhered to substrate.
12. Compatible materials have been used.
13. Transitions at changes in direction and structural support at gaps have been provided.
14. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
15. All penetrations have been sealed.

E. Field Tests:

1. Allow sufficient time for testing and inspection and provide a schedule in advance to the Testing Agency.
2. Whenever Work is to be done, notify Testing Agency in sufficient time to provide inspections.
3. Submit test results in accordance with specified standards, including retesting if initial results are not satisfactory.
4. Test to be distributed uniformly across all elevations.
5. Membrane Adhesion Test: Test materials for a minimum air-barrier adhesion of 16 lbf/sq. in. or to manufacturer's minimum adhesion level per substrates, whichever is greater in accordance with ABAA T0002. Perform test after curing period recommended by the manufacturer. Record mode of failure and area which failed in accordance with referenced standard. To be performed by installer and included on daily worksheet.

- a. Test Site Locations: Perform 1 test once daily per substrate during installation and a minimum of 4 test sites per major elevation per substrate. (Each test site includes 3 pull tests).
 - 1) Perform one test for the first 2500 sq. ft. of installed material for each wall assembly type.
 - b. Provide an inspection report in accordance with referenced standard that indicates whether or not the air barrier material has met the minimum adhesion level requirement and include photo documentation.
 - c. Provide reports within 3 days of test completion.
6. Qualitative Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186, chamber depressurization using detection liquids.
- a. Test Locations: Provide ten tests for each penetration type per 2500 sq. ft. of each substrate. Distribute test locations across all elevations.
 - b. Test Pressure: 500 Pa.
 - c. Pass/Fail Criteria: Visual observation of air leakage evidenced by continuous foaming "bubbling" of detection liquid is considered a failed test.
 - d. Provide an inspection report that indicates results and include photo documentation.
7. Qualitative Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186, chamber pressurization or depressurization with smoke tracers.
- a. Testing to be performed concurrent with Qualitative Water Infiltration Testing below.
 - b. Pass/Fail Criteria: Visual observation of air leakage evidenced by smoke tracer penetrating air barrier system is considered a failed test.
 - c. Provide an inspection report that indicates results, including photos.
8. Water Spray Test: Before installation of interior finishes has begun, areas designated by the Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
- a. Perform tests at transitions to adjacent wall assemblies, control joints, deflection joints, and expansion joints.
 - b. Test 500 linear feet of all joint locations.
 - c. Water Infiltration:
 - 1) Water leakage to the interior of the building is a failure.
 - 2) Water observed on interior surfaces of the system is a failure.
 - 3) Water observed on interior surfaces of adjacent systems, originating from the wall system or the transition to the adjacent systems, is a failure.
9. Wet Film Thickness Test (to be performed by installer at time of installation and included on ABAA QAP daily worksheet):
- a. Test material using wet film gauge to confirm that membrane meets manufacturer's indicated wet film thickness requirements.
 - b. Regularly check per coat per substrate type during installation per ABAA QAP.
 - c. Failure Criteria:
 - 1) A measurement less than manufacturer's required wet film thickness is considered a failure.
 - 2) Provide an inspection report indicating results and include photo documentation.
 - 3) Provide inspection report indicating results and include photo documentation.
10. Dry Film Thickness Test:
- a. Test material in accordance with manufacturer's requirements to confirm that cured membrane meets manufacturer's indicated dry film thickness requirements.
 - b. Three 1 inch x 4 inch samples removed from separate areas with gypsum facer intact to avoid stretching membrane.

- c. Test Locations: Once daily per substrate during installation and a minimum of 1 test per major elevation per substrate.
 - 1) Perform one test for the first 2500 sq. ft. of installed material for each wall assembly type.
 - 2) Provide an inspection report in accordance with referenced standard that indicates whether or not the air barrier material has met the minimum adhesion level requirement and include photo documentation.
 - 3) Provide reports within 3 days of test completion.
 - d. Failure Criteria:
 - 1) A measurement less than manufacturer's required dry film thickness is considered a failure.
 - e. Provide an inspection report indicating results and include photo documentation.
11. Air barriers will be considered defective if they do not pass tests and inspections.
- a. Wet Film Thickness: Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 - b. Upon failure of dry film testing or Adhesion Testing:
 - 1) Determine cause of failure.
 - 2) Provide one additional test for each occurrence of failure.
 - 3) Repair deficient air barrier components per manufacturer's recommendations.
 - 4) Repair tested areas per manufacturer's recommendations.
 - c. Upon failure of water spray testing:
 - 1) Determine cause of failure.
 - 2) Repair per manufacturer's recommendations and retest deficient air barrier components.
 - 3) Determine if deficient conditions are present elsewhere on the building and repair per manufacturer's recommendations.
 - 4) Provide 75 linear feet of additional tests for each occurrence of failure.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- G. Repair non-conforming substrates and fluid-applied water/air barrier material installation to conform with project requirements.
- H. Take corrective action to repair and replace, reinstall, seal openings, gaps, or other sources of air leakage to conform with project performance requirements.
- I. Clean air barrier materials that were affected by testing procedures to a level equal to or better than the original condition after testing is complete using cleaning agents and procedures recommended by manufacturer of affected construction.
- J. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

3.7 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
 - 1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for longer than allowed by manufacturer, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
 - 2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

- B. Repair or replace fluid-applied water/air barrier materials damaged during construction in accordance with manufacturers' recommendations at no additional cost to the District.
- C. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- D. Remove masking materials after installation.

END OF SECTION

SECTION 074213.13 - FORMED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Concealed-fastener, lap-seam metal panels for walls and screens.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
1. Meet with District, Architect, District's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
 6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 7. Review temporary protection requirements for metal panel assembly during and after installation.
 8. Review of procedures for repair of metal panels damaged after installation.
 9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied finishes.
1. Include Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:
1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.
- C. Provide the following upon request:
 - 1. Qualification Data: For Installer.
 - 2. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- D. Mockups: Build first-in-place mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical metal panel assembly as shown on Drawings, including portion with corner, soffits, supports, attachments, and accessories.
 - 2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration in accordance with AAMA 501.2.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.8 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Organic Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested in accordance with ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E 1592:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested in accordance with ASTM E 283 at the following test-pressure difference:
1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).
- C. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E 331 at the following test-pressure difference:
1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. General: Provide factory-formed metal panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
- B. Concealed-Fastener Metal Wall Panels, EXT-02#: Formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:

- a. Morin Matrix MX-2 (EXT-02A) and MX-6 (EXT-02B and EXT-02C), or comparable by one of the following:
 - 1) CENTRIA Architectural Systems.
 - 2) Fabral.
 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Nominal Thickness: 0.040 inch (1.02 mm) (20 gauge).
 - b. Surface: Smooth, flat finish.
 - c. Exterior Finish: Fluoropolymer.
 - 1) Color: As indicated on Drawings.
 3. Panel Coverage: 12 inches (305 mm).
 4. Panel Height: 1.5 inches (38 mm).
 5. Attachment Assembly: Manufacturer's standard attachment system attached to z-girt subframing system with continuous insulation board over sheathing.
- C. Concealed-Fastener Metal Screen Wall Panels, EXT-03: Formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
 - a. Morin Matrix MX-6, or comparable by one of the following:
 - 1) CENTRIA Architectural Systems.
 - 2) Fabral.
 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Thickness: 0.040 inch (1.02 mm).
 - b. Surface: Smooth, flat finish.
 - c. Exterior Finish, both exposed sides: Fluoropolymer.
 - 1) Color: As indicated on Drawings.
 3. Panel Coverage: 12 inches (305 mm).
 4. Panel Height: 1.5 inches (38 mm).
 5. Attachment Assembly: Manufacturer's standard attachment system attached to exposed HSS screen wall framing.

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate in accordance with equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
 - 1. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Colors: As indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 - 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration and water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels in accordance with manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.

6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
1. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
 2. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 3. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
 4. Flash and seal panels with weather closures at perimeter of all openings.
- E. Watertight Installation:
1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels; and elsewhere as needed to make panels watertight.
 2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: District will engage a qualified testing agency to perform tests and inspections.

- B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration in accordance with AAMA 501.2. Test air barrier penetrations after attachment of rainscreen brackets before and after installation of metal wall panels.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.
- D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
- E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 075419 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Adhered PVC membrane roofing system, including accessories, terminations, vapor retarders, insulation, flashing and other construction necessary to provide a leak-free, ponding-free roofing system.
 2. Walkway pads.
- B. Related Requirements:
1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
 2. Division 06 Section "Sheathing" for wood-based, structural-use roof deck panels.
 3. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counter-flashings.
 4. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.2 DEFINITIONS

- A. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
1. Individual product data sheets are to be fully annotated to clearly indicate specific product characteristics such as: thickness, dimensions, type, classification, etc.
- B. Shop Drawings: For roofing system, include plans, elevations, sections, project specific details, applicable manufacturer's standard details, and attachments to other work.
1. Base flashings and membrane terminations.
 2. Layout of tapered insulation and/or crickets including, but not limited to, slope, heights from drain, connections/securement to structural deck
 3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing, membrane adhesive patterns, and patterns and spacing of mechanically fastened of substrate boards.
 4. Adhesion patterns for insulation and cover board for corner, perimeter, and field-of-roof locations.
 5. Layout and quantity of walkway pads. Include plans, dimensions, connection to roof, and relationship to adjacent roofing appurtenances.
 6. All membrane-clad sheet metal configurations.
 7. Shop drawing showing Manufacturer's required number of perimeter half sheet for project specific uplift requirements, per building.
 8. Shop drawing showing Manufacturer's required plate and fastener spacing pattern for perimeters, base of walls, curbs, vent pipes or any other roof penetrations for project specific uplift requirements, per building.
 9. Include flashings, tie-ins, edges, terminations, expansion joints, penetrations and joints. Provide shop drawings for assemblies indicated below. Do not copy and provide Engineer's construction drawings as shop drawings.
- C. Samples for Verification: For the following products:
1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
 2. Roof insulation.
 3. Walkway pads, rolls, or pavers.

4. Metal termination bars.
5. Membrane cladded flashing; manufacturer's standard size.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer.
- B. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.
- C. Copy of Manufacturer's NOA forms.
- D. Approved Contractor Certification: Signed by manufacturer certifying that Contractor is a certified Contractor in good standing with the manufacturer and is qualified to perform the specified work and able to receive the required warranties.
- E. Work History Certification: Contractor's recent work history data of successful warranted installations similar to that of this Project within the last 5 years.
- F. Manufacturer's Certification: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 1. Submit evidence of compliance with performance requirements.
- G. Certificates: By manufacturers of roofing and accessory materials that all materials supplied comply with all requirements of the identified ASTM and industry standards or practices.
- H. Test Reports: UL Class A Fire Resistance approval.
- I. Sample Warranties: Sample copies of manufacturer and Contractor warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.
- B. Final roofing warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product, and has been continuously authorized for a minimum five (5) years prior to execution of agreement, and that is eligible to receive manufacturer's special warranty.
 1. Firm shall have successfully completed manufacturer's training as required.
 2. Installer personnel trained and authorized by the manufacturer shall complete all work pertaining to the installation of the Work of this Section, including membrane and flashings.
 3. Use adequate amounts of such qualified workmen who are thoroughly trained in the crafts and techniques required to properly install the type of roofing system specified and other work required to complete the Work specified and within the specified time.
- B. Manufacturer Qualifications: A qualified manufacturer that is UL listed for membrane roofing system identical to that used for this Project.
- C. There shall be no deviation made from the Project Specification or the approved Shop Drawings without prior written approval by the District, Architect, and membrane manufacturer.

- D. Suitability of Contract Documents: Verify that the Contract Documents are workable and not in conflict with the manufacturers' recommendations and instructions prior to the start of the Work. 1. Start of the Work constitutes acceptance of project conditions and requirements.
- E. Membrane roofing and associated Work shall be in compliance with NRCA recommendations. Where requirements of the Contract Documents are more stringent, the more stringent shall apply.
- F. Exterior Fire-Test Exposure: ASTM E 108 and UL 790, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
- G. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- H. Pre-installation Roofing Conference: Conduct conference at Project site.
 - 1. Meet with District, Architect, District's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - 7. Review governing regulations and requirements for insurance and certificates if applicable.
 - 8. Review temporary protection requirements for roofing system during and after installation.
 - 9. Review roof observation and repair procedures after roofing installation.
- I. Provide the following upon request:
 - 1. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
 - 2. Field quality-control reports.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

- E. Membrane rolls shall be stored lying down on pallets. Opened rolls shall be fully protected from the weather with clean canvas tarpaulins (visqueen). Un-vented polyethylene tarpaulins are not accepted due to the accumulation of moisture beneath the tarpaulin in certain weather conditions.
- F. Do not overload roof. Load materials so as not to cause structural damage or failure, or create a safety hazard.
- G. Adhesives shall be stored at temperatures between 40 degrees F and 80 degrees F unless manufacturers require more stringent temperature limits.
- H. Flammable materials shall be stored in a cool, dry area away from sparks and open flames. Follow precautions outlined on containers or supplied by material manufacturer/supplier.
- I. Materials which are determined to be damaged by the Consultant, Owner or the manufacturer are to be removed from the job site and replaced at no cost to the Owner.
- J. Keep storage area neat and orderly.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

- A. Manufacturer's Total System Warranty: Warranty all work under this section in a written document endorsed by the Manufacturer. Manufacturer's warranty must include membrane and all accessory products covering defects in workmanship and materials; and all corrective actions necessary to repair damage to the roof membrane and materials caused by roof leaks or improper application.
 - 1. Warranty shall include coverage of ponding water areas.
 - 2. Warranty Period: 20 years from date of Substantial Completion.
- B. Installer Warranty: Installer's workmanship warranty in which installer agrees to repair or replace components of membrane roofing system including, but not limited to, roofing, flashing or metal, that fail in materials or workmanship within the specified warranty period. Repair or replacement shall also include thermal barrier board, insulation, substrate board, and accessory products.
 - 1. Warranty shall include all corrective actions necessary to repair damage to the roof membrane and components caused by roof leaks or improper application
 - 2. Warranty shall cover leaks from failure to resist penetration of water during construction. Special Warranty includes roofing assembly from top of substrate deck to top of roofing including all components such as vapor retarders, fasteners, adhesives, roofing membrane, ballast, seals and sealants, flashing and venting.
 - 3. Warranty Period: Five (5) years from date of Substantial Completion.
- C. Warranties shall be written on form at the end of this Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated in accordance with ASCE/SEI 7.
 - 1. Corner Uplift Pressure: Refer to Drawings.
 - 2. Perimeter Uplift Pressure: Refer to Drawings.
 - 3. Field-of-Roof Uplift Pressure: Refer to Drawings.
- D. Solar Reflectance Index: Three-year-aged SRI not less than 64 or initial SRI not less than 82 when calculated in accordance with ASTM E 1980, based on testing identical products by a qualified testing agency.
- E. Energy Performance: Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested in accordance with CRRC-1.

2.2 PVC MEMBRANE ROOFING

- A. PVC Sheet: ASTM D 4434, Type II or III, Grade I, glass fiber or fabric reinforced, felt or fabric backed.
 - 1. Basis-of-Design Products: Subject to compliance with requirements, provide the following:
 - a. Sika Sarnafil; Sarnafil G410 (No known equal according to College campus standards)
 - 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: White

2.3 AUXILIARY MEMBRANE ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
 - 1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet membrane.
- C. PVC-Clad Metal Flashing: Manufacturer's standard.
 - 1. Product: Sika Sarnaclad
- D. Fluid Applied Flashing: PMMA or as recommended by membrane manufacturer
 - 1. Product: Sika Liquid Flashing
- E. Polyurethane resin: Low-VOC/odor, cold-applied, elastic, aliphatic, single component.

1. Product: Sika Sikalatic-641 Lo-VOC
- F. Bonding Adhesive: Manufacturer's standard.
- G. Slip Sheet: Manufacturer's standard, of thickness required for application.
- H. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- I. Joint Sealants: Refer to Section 079200 "Joint Sealants" for sealants used in conjunction with roofing and tie-ins to air barriers.
- J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint patches, lap sealants, sealant tape, tape strips, and aluminum tape, PVC-coated metal flashings and termination reglets, and other accessories.

2.4 SUBSTRATE BOARDS

- A. Glass-Mat Faced Gypsum Roof Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board, 1/2 inch thick; one of the following:
 1. Products, ASTM C1177: Subject to compliance with requirements, provide the following:
 - a. Georgia-Pacific Corporation; Dens Deck Roof Board, or comparable by one of the following:
 - 1) CertainTeed Corporation.
 - 2) National Gypsum Company.
 2. Products, ASTM C1278: Subject to compliance with requirements, provide the following:
 - a. USG Corporation; Securock Brand Gypsum-Fiber Roof Board.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 ROOF AIR BARRIER/VAPOR RETARDER

- A. Metal Roof Deck/Substrate Board or Existing Concrete Roof Deck Application:
 1. Self-Adhering-Sheet Vapor Retarder: Polyethylene film laminated to layer of modified bitumen adhesive, minimum 30-mil- total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide water-based primer when recommended by vapor retarder manufacturer.
 - a. Products:
 - 1) Sika Sarnafil; Sarnavap Self-Adhered.
 - 2) Sika Sarnafil; Vapor Retarder TA 138
- B. New Concrete Roof Deck Application; One of the following:
 1. SBS Modified Bitumen: ASTM D6164.
 - a. Type I.
 - b. Grade S.
 - c. Torch-applied.
 2. 2-ply Built-up Asphalt Roof:
 - a. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.
 - b. Roofing Asphalt: ASTM D 312, Type III or Type IV.
 - c. Asphalt Primer: ASTM D 41.

3. Self-Adhering Sheet Membrane specified above.

2.6 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by PVC membrane roofing manufacturer, of thicknesses indicated .
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 2, Grade 2 coated glass facer on both major surfaces.
 1. Board Size: 4'-0" x 4'-0"
 2. Thickness: Two layers minimum, total minimum thickness as indicated on drawing. Provide a minimum aged thermal resistance of R5 (deg. F.h.sf/Btu) per inch.
- C. Tapered Insulation: Provide factory-tapered insulation boards with identical characteristics as base insulation fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes with identical characteristics as base insulation where indicated for sloping to drain. Fabricate to slopes indicated.

2.7 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
- B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
 2. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
- C. Cover Board: ASTM C1177/C1177M, coated glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board, 1/2 inch thick; one of the following:
 1. Products, ASTM C1177: Subject to compliance with requirements, provide the following:
 - a. Georgia-Pacific Corporation; Dens Deck Prime Roof Board; factory primed, or comparable by one of the following:
 - 1) CertainTeed Corporation.
 - 2) National Gypsum Company.
 2. Products, ASTM C1278: Subject to compliance with requirements, provide the following:
 - a. USG Corporation; Securock Brand Gypsum-Fiber Roof Board.
- D. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.
- E. Sprayed Polyurethane Foam: One- or two-component, foamed-in-place, closed cell polyurethane foam, 1.5- to 2.0-lb/cu. ft density; flame-spread index of 25 or less in accordance with ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam manufacturer.

2.8 ASPHALT MATERIALS

- A. Roofing Asphalt: ASTM D 312, Type III or Type IV.
- B. Asphalt Primer: ASTM D 41.

2.9 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 - 1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
 - 4. Verify that concrete has cured and aged for minimum time period required in writing by roofing manufacturer. Perform testing as required by roofing manufacturer for test type, rate, and quantity to validate that substrate is acceptable, dry, and free of moisture.
 - 5. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SUBSTRATE CONDITION

- A. Contractor shall be responsible for acceptance or provision of proper substrate to receive roofing materials.
- B. Verify that the work done under related sections meets the following conditions:
 - 1. Roof drains and/or scuppers have been reconditioned and/or replaced and installed properly.
 - 2. Roof curbs and nailers are properly secured and prepared to receive roofing materials.
 - 3. Surfaces are smooth, dry and free of dirt, debris and incompatible materials.
 - 4. Surfaces are free of standing water and visible moisture.
- C. Rusted or deteriorated substrate shall be repaired or removed and replaced. Deck type and attachment shall conform to local code requirements.
- D. Broken, delaminated, wet or damaged insulation or cover boards shall be removed and replaced.
- E. The substrate shall be clean, smooth, dry, free of flaws, sharp edges, loose and foreign material, oil and grease and be structurally sound. Sharp ridges, other projections and accumulations of bitumen above the surface shall be removed to ensure a smooth surface before roofing. Roofing shall not start until all defects have been corrected.
- F. Fastener Pull-out Tests: Perform pull-out tests to determine appropriate rate and type of fastener installation in presence of manufacturer's technical representative.
- G. Adhesion Tests: Perform pull-out tests to determine appropriate rate and pattern of adhesive installation in presence of manufacturer's technical representative.

3.3 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. The roof deck and roof construction must be structurally sound to provide support for the roofing system. Pre-load materials on the rooftop in such a manner to eliminate risk of deck overload due to concentrated weight.
- D. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
 - 1. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with membrane roofing system manufacturers' written instructions.

3.5 ROOF AIR BARRIER/VAPOR RETARDER INSTALLATION

- A. General:
 - 1. Install vapor/air barrier primer and membrane over a clean and dry substrate. Do not install when it is raining, snowing, or on wet/humid surfaces.
 - 2. Begin application of vapor/air barrier membrane at the bottom of the slope. Chalk a line on the substrate to align the sheet.
 - 3. Unroll, position, and align the vapor/air barrier membrane with the release liner covered selva edge on the up-slope side. After the sheet is placed in its final position, loosely reroll half the sheet toward the center of the roll.
 - 4. Carefully score the release liner across the width of the roll with a straight blade utility knife. Roll vapor/air barrier membrane into its final position as the release liner is being removed. Re-roll the remaining vapor/air barrier membrane and repeat the process.
 - 5. Roll vapor/air barrier membrane with a 100 lb steel roller to ensure full contact with the substrate. Finish by aligning the edge of the roller with the lower end of the side laps and rolling up the membrane. Do not cut the membrane to remove air bubbles trapped under the laps. Squeeze out air bubbles by pushing the roller to the edge of the laps.
 - 6. Stagger adjacent end laps a minimum of 12".
- B. Metal Roof Deck/Substrate Board or Existing Concrete Roof Deck Application:
 - 1. Self-Adhering-Sheet Air Barrier/Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet air barrier/vapor retarder over area to receive air barrier/vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.
- C. New Concrete Roof Deck Application:
 - 1. SBS Modified Bitumen: Torch apply 1 ply of SBS modified bitumen vapor retarder in accordance with manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
 - 2. Built-up Vapor Retarder:

- a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. or as required by manufacturer and allow primer to dry.
 - b. Install two glass-fiber felt plies lapping each felt 19 inches over preceding felt.
 - c. Embed each felt in a solid mopping of hot roofing asphalt.
 - d. Glaze coat completed surface with hot roofing asphalt.
 - e. Apply hot roofing asphalt within plus or minus 25 deg F of equiviscous temperature.
3. Self-Adhering-Sheet Air Barrier/Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet air barrier/vapor retarder over area to receive air barrier/vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.
- D. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.
1. Apply mastic to seal around penetrations. Use a trowel to mound mastic around the penetrations to seal the opening. Do not apply mastic where it may come into direct contact with the PVC membrane.
- E. Provide an air tight transition to the wall air barrier.

3.6 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
1. Prime surface of vapor retarder as instructed by insulation adhesive manufacturer; allow primer to dry.
 2. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 3. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together .
1. Adhere cover boards with adhesive to resist uplift pressure at corners, perimeter, and field of roof.
- I. Install slip sheet over insulation cover board and immediately beneath membrane roofing.

- J. Sprayed Polyurethane Foam: Apply in accordance with manufacturer's written instructions.

3.7 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere membrane roofing over area to receive roofing and install in accordance with membrane roofing system manufacturer's written instructions and according to requirements contained within this Section, whichever is more stringent.
 - 1. Install sheet in accordance with ASTM D 5036.
- B. Install PVC membrane roofing system with positive slope to drains, free of standing (ponding) water. Install membrane roofing free of wrinkles
- C. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
- D. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing. Adhesive shall be applied in smooth, even coats with no gaps, globs or similar inconsistencies.
- F. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, perimeter of roofing, base of wall, drains, curbs, perimeter of roofing and where indicated or required by manufacturer to meet uplift requirements.
- G. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
- H. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings in accordance with manufacturer's written instructions to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
 - 2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
- I. Install T-joint patches at all 3-way (or greater) membrane overlaps/intersections.
- J. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
- K. At existing building, install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

3.8 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates in accordance with membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing. Adhesive shall be applied in smooth, even coats with no gaps, globs or similar inconsistencies.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars where indicated.
 - 1. Coordinate flashing with counterflashing/coping installation.
- F. Flashings shall be installed concurrently with the roof membrane as the job progresses. Membrane shall be fully welded each day.
- G. No temporary flashings shall be allowed without the prior written approval of the Consultant and manufacturer. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing, the affected area shall be removed and replaced at the Contractor's expense. Flashing shall be adhered to compatible, dry, smooth, and solvent-resistant surfaces. Use caution to ensure adhesive fumes are not drawn into the building.
- H. All flashings shall be installed concurrently with the roof membrane in order to maintain a watertight condition as the work progresses.
- I. Refer to detail drawings for flashing work. Comply with manufacturer requirements if more stringent.
- J. Provide enhanced securement of the membrane at the base of parapets, walls, curbs, penetrations, and drains. Refer to detail drawings.
- K. Terminate and seal top of penetration flashings with stainless steel wormgear clamp and sealant.
 - 1. Coordinate flashing with membrane umbrella installation complete with stainless steel Wormgear clamp and sealant.
- L. Flashings shall extend a minimum of 8 inches above roofing level. Flashings that exceed 30 inches in height shall receive additional securement. See Contract Drawings for additional securement requirements.

3.9 MISCELLANEOUS MATERIALS

- A. Spray Foam: Mix and install in accordance with manufacturer's written instructions. 1. Apply in thickness between ½-inch and 2-inches. 2. Allow material to cool prior to applying additional thickness. Do not apply additional spray foam while prior application is still rising. 3. Protect spray foam from heat sources including, but not limited to, welding and cutting equipment.
- B. Pipe/Conduit Supports: Install pipe supports where indicated and where necessary to support piping. Secure piping to pipe support in accordance with manufacturer's written instructions and recommendations.
- C. Aluminum Tape: Install aluminum tape as a means of separating membrane from contaminated material, bituminous coated cast iron pipes, and any other materials incompatible with membrane.

3.10 TEMPORARY CUT-OFF

- A. All temporary waterstops shall be constructed to provide a 100 percent watertight seal.
- B. The waterstop shall be sealed to the (e) roofing that water will not be allowed to travel under the new or existing roofing.
- C. If inclement weather occurs while a temporary waterstop is in place, the Contractor shall provide the labor necessary to monitor the situation to maintain a watertight condition.

- D. The edge of the membrane shall be sealed in a continuous heavy application of manufacturer approved sealant.
- E. When work resumes, the contaminated membrane shall be cut out. All sealant, contaminated membrane, insulation fillers and other components of waterstop shall be removed from the work area and properly disposed of off-site. None of these materials shall be used in the new work.
- F. If any water is allowed to enter under the newly-completed roofing, the affected area shall be removed and replaced at the Contractor's expense.

3.11 CLOSEOUT ACTIVITIES

- A. Final Roof Membrane Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Consultant.
 - 1. Notify Consultant and Owner 48 hours in advance of date and time of inspection.
 - 2. Substantial Completion: A "no-defect" final roof membrane inspection report is required prior to the Contractor requesting the Substantial Completion review.

3.12 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.
- B. Roofing membrane to receive walkway membrane shall be clean and dry.
- C. Inspect deck membrane seams that are to be covered by walkway pads with probing tool and re-weld any inconsistencies before walkway installation.
 - 1. Area to receive walkway protection membrane shall be reviewed and approved by the Architect and manufacturer prior to the installation of the walkway pads.
- D. Clean the deck membrane in areas to be welded.
- E. Provide 4-inch gap between walkway sections and between walkway and roof mounted items.
- F. Fully weld perimeter walkway.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: District will engage a qualified testing agency to perform tests and inspections.
- B. Tests:
 - 1. Fastener pull-out resistance tests performed by the manufacturer's technical representative. Testing shall be performed on walls and in the field of the roof. Coordinate with the manufacturer's technical representative.
 - 2. Adhesion tests performed by the manufacturer's technical representative. Testing shall be performed in the field of the roof. Coordinate with manufacturer's technical representative.
- C. Final Roof Membrane Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
 - 1. Notify Architect and District 48 hours in advance of date and time of inspection.
 - 2. Substantial Completion: A "no-defect" final roof membrane inspection report is required prior to the Contractor requesting the Substantial Completion review.

- D. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
- E. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.14 PROTECTING AND CLEANING

- A. Remove and dispose of roofing debris on a daily basis. Protect all newly installed roof surfaces.
- B. Repair or replace components of roofing system and finished surfaces damaged or defaced due to the Work of this Project; comply with recommendations of manufacturers of components and surfaces.
- C. Contractor is responsible for the cleaning and removal of all debris or residue that is tracked from existing roof areas to the installed thermoplastic membrane.
- D. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and District.
- E. Where construction traffic must continue over finished roof membrane, provide durable protection and replace or repair damaged roofing to original condition.
- F. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.
- G. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

Roofing Special Warranty Form follows

ROOF SYSTEM SPECIAL WARRANTY FORM

Project Title:

Project Address:

Architect's Project No. Contractor's Job Number:

Warranted Work (and location description if less than full roof):

Specification Section No. and Title:

Length of Warranty: _____ years

The undersigned herewith warrant that the above stated Work has been executed in conformance with the requirements of the Contract Documents for the Project named and warrant said Work to perform as specified and without failure for the above stated period of time,

starting on _____, 20____, and ending on _____, 20____.

This warranty does not apply to failure to perform due to abuse or neglect by the District, or the District's successor in interest, or damage by vandalism.

Contractor (the entity holding direct contract with District)	Firm
	Representative*
	Signed
	Title
	Notary
	Date

Roofing Installer [] Same as Contractor (if same as Contractor, check box; leave lines blank)	Firm
	Representative*
	Signed
	Title
	Notary
	Date

Roofing Membrane Manufacturer	Firm
	Representative*
	Signed
	Title
	Notary
	Date

*The Firm's Representative affirms they are authorized to bind the Firm to this Warranty.

END OF SPECIAL WARRANTY FORM

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Custom flashing and trim fabrications and accessories, including the following:
1. Sheet metal materials, including:
 - a. Formed roof drainage sheet metal fabrications, including built-in gutters.
 - b. Formed low-slope roof sheet metal fabrications.
 - c. Formed wall sheet metal fabrications.
 2. Manufactured reglets and counterflashing
 3. High temperature self-adhering underlayment and flashing.
 4. Joint sealants associated with sheet metal flashing.
 5. Other sheet metal as indicated
 6. Miscellaneous materials.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site prior to commencement of field installation to establish procedures to maintain required working conditions and to coordinate this Work with related and adjacent Work.
1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
 3. Review requirements for insurance and certificates if applicable.
 4. Review sheet metal flashing observation and repair procedures after flashing installation.
 5. Verify that final details comply with current recommendations published in SMACNA's "Architectural Sheet Metal Manual" and NRCA's Roofing and Waterproofing Manual.
 6. Meeting attendees shall include representatives for the Contractor, District, Architect, inspection agency, sheet metal contractor and installers of related and adjacent Work affected by or affecting sheet metal Work.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For sheet metal flashing and trim.
1. Plans, elevations, sections, and attachment details.
 2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
 3. Identification of material, thickness, weight, and finish for each item and location in Project.
 4. Reference applicable Drawing details on all Shop Drawing details.
 5. Details for forming, including profiles, shapes, seams, and dimensions.
 6. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 7. Details of termination points and assemblies, including fixed points.
 8. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
 9. Details of roof-penetration flashing.
 10. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
 11. Details of saddles, transitions and terminations in sheet metal flashing.
 12. Details of special conditions.

13. Details of connections to adjoining work.
 14. Details of perimeter conditions.
 15. Detail formed flashing and trim at scale of not less than 3 inches per 12 inches.
- C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.
- D. Samples for Verification: Actual sample of finished products for each type of exposed finish for sheet metal and other metal accessories.
1. Sheet Metal Flashing and Trim: 12 inch long by actual width of unit. Include finished seam with required profile. Include fasteners, cleats, clips, closures, and other attachments.
 2. Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
 3. Fasteners, Accessories and Miscellaneous Materials: Full-size Samples.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Entity that employs a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers.
1. For roof edge flashings and copings that are ANSI/SPRI/FM 4435/ES-1 tested, fabrication shop shall be listed as able to fabricate required details as tested and approved.
- C. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- D. Provide the following upon request:
1. Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested.
 2. Product Test Reports: For each product, for tests performed by a qualified testing agency.
 3. Research Reports: For copings and roof edge flashing, from an agency acceptable to authority having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.
 4. Qualification Statements: For fabricator and installer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.7 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.8 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace sheet metal flashing and trim that does not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Special Warranty on Organic Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. SPRI Wind Design Standard: Manufacture and install roof edge flashings, copings and cleats tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 - 1. Design Pressure: As indicated on Drawings.
- C. Install systems to allow movement of components without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subjected to 100-year seasonal temperature ranges.
- D. Install specialized, custom fabricated, sheet metal saddles for waterproof performance at terminations and transitions of sheet metal flashing and trim such as multi-plane intersects, and:
 - 1. Where indicated.
 - 2. Where constructed conditions will not provide watertight performance without saddles.
- E. Contractor shall inspect transitions and terminations to make Project watertight. Contract Documents indicate design intent and may not indicate all instances where saddles apply. Field verify locations where saddles are required.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METAL MATERIALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Aluminum Sheet: Coil-coated sheet, ASTM B209/B209M, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
1. Thickness: As indicated.
 2. Surface: Smooth, flat
 3. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Color: As indicated.
 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).
- C. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 (Z275) coating designation; structural quality.
1. Surface: Smooth, flat.
 2. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
- D. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 coating designation,; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
1. Surface: Smooth, flat.
 2. Exterior Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621, as applicable. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Color: As indicated.
 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.
- E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, dead soft, fully annealed.
1. Surface: Smooth, flat.
 2. Exterior Finish: ASTM A480/A480M, No. 2D (dull, cold rolled)
 - a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- F. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, dead soft, fully annealed.
1. Surface: Smooth, flat.
 2. Exterior Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621, as applicable. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Color: As indicated.

G. Exterior Finish: Lead Sheet: ASTM B749 lead sheet.

1. Thickness: 4 lb (1.8 kg).

2.3 UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment: Self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970/D1970M.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F or lower; ASTM D1970/D1970M.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carlisle WIP Products; a brand of Carlisle Construction Materials.
 - b. GCP Applied Technologies.
 - c. Henry Company; a Carlisle company.
 - d. Owens Corning.
 - e. Protecto Wrap Company.
4. Basis-of-Design Product: GCP Applied Technologies; Grace Ultra, or approved equal by listed manufacturer.

B. Self-Adhering, High-Temperature Sheet Flashing: Self-adhering, cold-applied, sheet flashing, polyethylene faced: minimum of 30 mils thick; slip-resistant, polyethylene-film-reinforced top surface laminated to butyl rubber adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970/D1970M.
2. Basis-of-Design Product: GCP Applied Technologies; Grace Ultra, or approved equal by listed underlayment manufacturer.
3. For use when not in contact with Weather Barrier. Refer to Section 072726, "Fluid-Applied Membrane Air Barriers" for high-temperature product when in contact with weather barrier.

C. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, solder, welding rods, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item. Nails secured into wood shall be annular threaded.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

5. Fasteners for Stainless-Steel Sheet Metal to Stainless-Steel Sheet Metal Components: No.10, stainless steel sheet metal screws equipped with sealing washers.
 6. Drive Pin Anchors: Subject to compliance with requirements provide Zamac Nailin; Powers Fasteners or approved equal.
 - a. Body: Zamac alloy, mushroom.
 - b. Pin: Type 316 stainless steel.
 7. Fastener Length: Fasteners shall be sized to penetrate substrate not less than 1-1/4 inches or not less than 3/4 inch through wood substrates.
- C. Solder:
1. For Zinc-Coated (Galvanized) Steel: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
 2. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant complying with Section 079200 "Joint Sealants"; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C1311, single-component, solvent-release, non-curing butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement complying with Section 079200 "Joint Sealants."
1. Provide butyl sealant between sheet metal laps, at concealed locations, and where indicated.
- G. Concealed Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
1. Provide pre-shimmed butyl sealant tape between sheet metal laps, at concealed locations, and where indicated.
- H. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- I. Sealing Washers: Stainless steel backed EPDM washers.
- J. Heavy Duty Wire Downspout Strainer: Stainless Steel Leaf Sieve
1. Product: Gromo No. 54006, or equal.
 - a. Size: 100
- K. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.
- L. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.
- 2.5 FABRICATION, GENERAL**
- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
 6. Sheet metal components requiring fabrication must have shop drawings submitted and approved prior to fabrication and delivery to the project site. Materials delivered to the project site without the required Architect's approval shall be immediately removed from the site and not incorporated into the completed Work.
 7. Obtain field measurements for accurate fit before shop fabrication.
 8. Solder sheet metal prior to application of finish.
 9. Flashings shall have minimum 4 inch vertical back leg and 2 inch overlap at exposed side.
- B. Fabrication Tolerances:
1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 ft. on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- G. Seams: Solder seams watertight with the exception seams of prefinished metals including those coil-coated, seams requiring movement and seams otherwise indicated in Drawings or as specified.
1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder. Pop rivet pieces together at 1 inch on center prior to soldering. Sweat solder under the lap. Solder rivet holes watertight.
 2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Do not bead solder. Rivet joints where necessary for strength. Solder rivet holes to be watertight.
 3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.
- H. Coil-Coated Seams: Fabricate nonmoving seams with flat-lock seams. Lap seams 4 inches and seal in a full bed of butyl sealant. Apply butyl sealant so it does not ooze out of seam. Rivet joints at 1 inch on center. Apply polyurethane sealant over rivets.
- I. Form pieces to a minimum length of 8 feet with the exception of pieces with a total length of less than 8 feet.
- J. Form pieces to maximum length of 10 feet.
- K. Corners: Sheet metal corner flashing shall be fully soldered to form one watertight piece.

- L. Hem exposed edges on underside 1/2 inch.
- M. Fabricate head flashing, sill flashing and similar with end closures and end dams soldered/welded watertight.
- N. Provide drip edges where indicated on the Contract Drawings.
- O. Provide 4 inch wide (minimum) horizontal flanges where dimension is not indicated on Contract Drawings
 - 1. Locations: Where flanges are stripped in or lapped for weather protection.
- P. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Built-in Gutters:
 - 1. Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.
 - 2. Fabricate in minimum 96-inch- (2400-mm-) long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
 - 3. Fabricate gutters with built-in expansion joints and gutter-end expansion joints at walls and pockets.
 - 4. Accessories: Wire-ball downspout strainer.
 - 5. Fabricate from the following materials:
 - a. Stainless Steel: 0.0156 inch thick.
- B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
 - 1. Fabricate from the following materials:
 - a. Galvanized Steel: 0.022 inch thick.
 - 2. Fabricated Hanger Style: SMACNA figure designation 1-35A, or approved equal.
 - 3. Fabricated Hanger Size: 1 inch wide by 1/16 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Custom Fabricated Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12 ft.- (3.6 m) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, solder or weld watertight. Shop fabricate interior and exterior corners.
 - 1. Fabricate from the following materials:
 - a. Galvanized Steel: 0.040 inch thick.
- B. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
 - 1. Galvanized Steel: 0.028 inch thick.
- C. Membrane Clad Metal: Refer to PVC roofing Section. Fabricate from the following materials.
 - 1. Galvanized Steel: 0.028 inch (0.71 mm) thick.
 - 2. Unreinforced PVC membrane laminated on one side, 20 mil thick.
 - 3. Color: Match membrane roofing.
- D. Edge Metal: Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
- E. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch thick.
- F. Flashing Receivers: Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch thick.
- G. Roof-Penetration Flashing: Fabricate from one of the following materials:
1. Stainless Steel: 0.0188 inch thick.
 2. Lead: 4 lb.
- H. Roof-Drain Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.0156 inch thick.

2.8 WALL SHEET METAL FABRICATIONS

- A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
1. Head and Jamb: Galvanized Steel: 0.028 inch thick.
 2. Sill: Stainless Steel: 0.025 inch thick.
- B. Miscellaneous Wall Flashings: Where indicated or required, fabricate wall sheet metal flashings with minimum 4 inch vertical leg. Fabricate from the following materials:
1. Base Flashing: Galvanized Steel: 0.028 inch (0.56 mm) thick.
 2. Counterflashing: Galvanized Steel: 0.028 inch (0.56 mm) thick.
 3. Cleats: Galvanized Steel: 0.040 inch thick, minimum complying with performance requirements. Saddles: Galvanized Steel: 0.028 inch thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Saddles, Transitions, and Terminations in Sheet Metal Flashing and Trim: Fabricate from the following materials:
1. Wall/Siding Related Flashing: Galvanized steel 0.028 inch , unless otherwise noted.
 2. Deck Related Flashing: Stainless steel 0.040 inch, unless otherwise noted.
- B. Provide specialized, custom fabricated, sheet metal saddles for waterproof performance at the following locations:
1. At terminations and transitions of sheet metal flashing and trim and construction components such as multi-plane intersects.
 2. Where constructed conditions will not provide watertight performance without saddles.
 3. Contractor shall inspect transitions and terminations to make Project watertight. Contract Documents indicate design intent and may not indicate all instances where saddles apply. Field verify locations where saddles are required.
 4. Where indicated.
- C. Fabricate saddles with diverters, minimum 1/2 inch high by 1 inch deep at multi-plane intersects and where indicated as occurs.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering, High-Temperature Sheet Underlayment:
 - 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
 - 2. Prime substrate if recommended by underlayment manufacturer.
 - 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 - 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
 - 5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
 - 6. Roll laps and edges with roller.
 - 7. Cover underlayment within 14 days.
- B. Install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.
 - 1. Install in shingle fashion to shed water.
 - 2. Lapp joints not less than 4 inches.

3.3 INSTALLATION OF HIGH TEMPERATURE SELF-ADHERING FLASHING

- A. Self-Adhering, High-Temperature Flashing: Install self-adhering sheet flashing, wrinkle free.
 - 1. Apply primer prior to installing high temperature self-adhering flashing.
 - 2. Comply with temperature restrictions of manufacturer for installation; use primer rather than nails for installing self-adhering flashing at low temperatures.
 - 3. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover self-adhering flashing within 14 days.

3.4 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
 - 1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, or sealant.
 - 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
 - 5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.

6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 8. Do not field cut sheet metal flashing and trim by torch.
 9. Install sealant tape where indicated.
 10. Torch cutting of sheet metal flashing and trim is not permitted.
 11. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or as recommended by SMACNA or NRCA.
1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of 10 ft. with no joints within 24 inches of corner or intersection.
 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
 3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.
 - a. Embed hooked flanges of joint members not less than 1 inch into sealant.
 - b. Form joints to completely conceal sealant.
 - c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40 deg F.
 - e. Lap sheet metal flashing and trim 4 inches in a full bed of sealant. Sealant shall be fully concealed. Remove visible sealant.
 - f. Rivet sealed laps at 1 inch on center. Apply sealant over rivets.
 - g. Install compatible sealants where required to prevent direct weather penetration.
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
 2. Do not solder aluminum, membrane-clad sheet metal, and prefinished sheet metal.
 3. Do not use torches for soldering.
 4. Heat surfaces to receive solder, and flow solder into joint.
 - a. Fill joint completely.
 - b. Completely remove flux and spatter from exposed surfaces.

5. Stainless Steel Soldering:
 - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
 - b. Promptly remove acid-flux residue from metal after tinning and soldering.
 - c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
6. Flat lock seams and lap seams, where soldered, shall be at least 1/2 inch. Pop rivet pieces together 1 inch on center prior to soldering. Seal solder under the lap. Do no bead solder. Solder rivet holes watertight.
7. Rivets: Rivet joints where indicated and where necessary for strength.
8. Thoroughly wash all flux off work after soldering. Failure to do so may result in damages to finishes.

H. Paint metal where indicated according to section 099113 "Exterior Painting."

3.5 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standards unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Built-in Gutters:
 1. Join sections with riveted and soldered joints
 2. Provide for thermal expansion.
 3. Slope to downspouts.
 4. Provide end closures and seal watertight with sealant.
 5. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 ft. apart. Install expansion-joint caps.
- C. Downspouts:
 1. Connect downspouts to gutter. Join sections with 1-1/2-inch (38-mm) telescoping joints.
 2. Provide hangers with fasteners designed to hold downspouts securely to walls.
 3. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c.
 4. Provide elbows at base of downspout to direct water away from building.
 5. Connect downspouts to underground drainage system.
 6. Install splash block under downspout in case underground drainage system does not occur.

3.6 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standards.
 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes as indicated.
 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Copings:
 1. Install copings in accordance with ANSI/SPRI/FM 4435/ES-1.
 2. Anchor to resist uplift and outward forces in accordance with performance requirements, recommendations in cited sheet metal standards, and as indicated, unless otherwise indicated.
 - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate..
 - b. Anchor interior leg of coping with washers and screw fasteners through slotted holes.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless steel draw band and tighten.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches (100 mm) over base flashing.
3. Lap counterflashing joints minimum of 4 inches (100 mm) and bed with sealant..
4. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant or interlocking folded seam or blind rivets and sealant unless otherwise indicated.

- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.7 INSTALLATION OF WALL SHEET METAL FABRICATIONS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standards unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
1. Provide concealed fasteners where possible, set units true to line, and level as indicated.
 2. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.8 MISCELLANEOUS FLASHING INSTALLATION

- A. Saddles, Transitions, and Terminations: Coordinate installation of saddles, transitions, and terminations with installation of exterior cladding, self-adhering sheet waterproofing, weather resistive barrier, and other components of the construction as occurs.
1. Miscellaneous flashing not installed in accordance with the Contract Documents will require the removal and reinstallation of construction to properly install the required flashing at no additional cost to the District.

3.9 INSTALLATION TOLERANCES

- A. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 ft. on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.10 CLEANING

- A. Clean and neutralize flux materials. Clean off excess solder.
- B. Clean off excess sealants.
- C. Clean exposed metal surfaces of substances with uniform oxidation and weathering.

3.11 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.

- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Manufactured units for the following applications:
 - 1. Copings.
 - 2. Reglets and counterflashings.
 - 3. Underlayment.

- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated, sheet metal flashing and trim.
 - 3. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, vents, and other manufactured roof accessory units.
 - 4. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
 - 2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 - 3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of roof specialty.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Shop Drawings: For roof specialties.
 - 1. Plans, expansion-joint locations, keyed details, and attachments to other work. Distinguish between factory pre manufactured- and field-assembled installation.
 - 2. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
 - 3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
 - 4. Details of termination points and assemblies, including fixed points.
 - 5. Details of special conditions.

- C. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

- D. Samples for Verification:
 - 1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
 - 2. Include copings made from 12-inch (300-mm) lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roof specialties.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products that are ANSI/SPRI/FM 4435/ES-1 tested to specified design pressure.
- B. Provide the following upon request:
 - 1. Product Certificates: For each type of roof specialty copings that is ANSI/SPRI/FM 4435/ES-1 tested.
 - 2. Product Test Reports: For copings, for tests performed by a qualified testing agency.
 - 3. Research Reports: For copings, from an agency acceptable to authorities having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.
 - 4. Qualification Statements: For manufacturer.

1.6 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof edge as indicated on Drawings.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.9 COORDINATION

- A. Coordinate roof specialties with roofing system, exterior wall system, air barrier, flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, weathertight, secure, and noncorrosive installation.
 - 1. Performance Coordination: Coordinate with the Work of roofing and exterior wall Sections to ensure that roof specialties provided under the Work of this Section meet or exceed specified roofing and exterior wall design performance requirements.
- B. Confirm and coordinate compatibility of materials and comply with warranty requirements of roofing system manufacturer.
- C. Coordinate roof specialties layout and seams with sizes and locations of joints and seams in adjacent materials.

1.10 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 075419 "Polyvinyl-Chloride (PVC) Roofing."
- B. Special Warranty on Organic Finishes: Manufacturer agrees to repair finishes or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. SPRI Wind Design Standard: Manufacture and install copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressures:
 - 1. Design Pressure: As indicated on Drawings.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 MANUFACTURED COPINGS

- A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 ft. (3.6 m), concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cheney Flashing Company.
 - b. Hickman; an MTL Company.
 - c. Metal-Era, Inc.
 - d. OMG Roofing Products; a Division of OMG, Inc.
 - e. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
 - 2. Metallic-Coated Steel Coping Caps: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal 0.034-inch (0.86-mm) thickness.
 - a. Surface: Smooth, flat finish.
 - b. Finish: Two-coat fluoropolymer.
 - c. Color: As indicated.
 - 3. Corners: Factory mitered and soldered.
 - 4. Coping-Cap Attachment Method: face leg hooked to continuous cleat with back leg fastener exposed, fabricated from coping-cap material.

- a. Snap-on Coping Anchor Plates: Concealed, stainless-steel sheet, 12 inches (300 mm) wide, with integral cleats.
5. Custom Formed Copings: Refer to Section 076200 "Sheet Metal Flashing and Trim."

2.3 REGLETS AND COUNTERFLASHINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Cheney Flashing Company.
 2. Fry Reglet Corporation.
 3. Heckmann Building Products, Inc.
 4. Hohmann & Barnard Company (Sandell Industries, Inc.)
 5. Keystone Flashing Company, Inc.
 6. Hickman, W. P.
 7. Hohmann & Barnard, Inc.
- B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
 1. Metallic-Coated Steel Sheet: Nominal 0.022-inch (0.56-mm) thickness.
 - a. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 2. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 3. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
 4. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
 5. Multiuse Type, Embedded: For multiuse embedment in cast-in-place concrete.
- C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 ft. (3.6 m) designed to snap into reglets and compress against base flashings with joints lapped, from the following exposed metal:
 1. Metallic-Coated Steel Sheet: Nominal 0.022-inch (0.56-mm) thickness.
 - a. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
- D. Accessories:
 1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

2.4 SHEET METAL MATERIALS

- A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Mill phosphatized for field painting where indicated, otherwise as follows:
 1. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

- a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight in color coat.
2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.5 UNDERLAYMENT

- A. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum 30 mils (0.76 mm) thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970/D1970M.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (minus 29 deg C) or lower; ASTM D1970/D1970M.
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ATAS International, Inc.
 - b. Carlisle WIP Products; a brand of Carlisle Construction Materials.
 - c. GCP Applied Technologies Inc.
 - d. Palisade; Brand of Intertape Polymer Group (IPG).
 - e. Polyglass U.S.A., Inc.
 - f. Protecto Wrap Company.
- B. Slip Sheet: Rosin-sized building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum.

2.6 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation. Refer to Section 076200 "Sheet Metal Flashing and Trim" for information not included here.
- B. Fasteners: Roof specialty manufacturer's recommended fasteners, designed to meet performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
 1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
 2. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
- C. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- D. Elastomeric Sealant: ASTM C920, elastomeric polyurethane silicone polymer sealant complying with Section 079200 "Joint Sealants" of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized complying with Section 079200 "Joint Sealants"; heavy bodied for hooked-type joints with limited movement.
- F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- G. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.7 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering, High-Temperature Sheet Underlayment:
 - 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
 - 2. Prime substrate if recommended by underlayment manufacturer.
 - 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 - 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses.
 - 5. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller.
 - 6. Roll laps and edges with roller.
 - 7. Cover underlayment within 14 days.
- B. Slip Sheet: Install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.
 - 1. Install in shingle fashion to shed water.
 - 2. Lap joints not less than 4 inches (100 mm).

3.3 INSTALLATION, GENERAL

- A. Install roof specialties in accordance with manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
 - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.

4. Torch cutting of roof specialties is not permitted.
 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer's written installation instructions.
1. Coat concealed side of uncoated aluminum and stainless steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of 12 ft. (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
 2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended in writing by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal concealed joints with butyl sealant as required by roof specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
- H. Rivet for strength. Seal rivets watertight.

3.4 INSTALLATION OF COPINGS

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
 1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at spacing that meets performance requirements.

3.5 INSTALLATION OF REGLETS AND COUNTERFLASHINGS

- A. Coordinate installation of reglets and counterflashings with installation of base flashings.
- B. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.
- C. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.6 CLEANING AND PROTECTION

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Manufactured units for the following applications:
 - 1. Roof curbs.
 - 2. Equipment supports.
 - 3. Roof hatches.
 - 4. Pipe supports.
 - 5. Preformed flashing sleeves.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each type of roof accessory and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items, including mechanical and electrical equipment, ductwork, piping, and conduit.
 - 4. Required clearances.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof accessories in contact with other materials that might cause staining, denting, or other surface damage. Store roof accessories in accordance with manufacturer's instructions.
- B. Store materials off ground in dry location and in accordance with manufacturer's instructions in well-ventilated area.
- C. Store and protect roof accessories from nicks, scratches, and blemishes.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-accessory substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.7 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.2 ROOF CURBS

- A. Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Curbs Plus, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. LMCurbs.
 - 4. Pate Company (The).
 - 5. Roof Products, Inc.
 - 6. Thybar Corporation.
- C. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- D. Supported Load Capacity: coordinate load capacity with information on Shop Drawings of equipment to be supported.
- E. Stainless Steel: 0.0781 inch thick sheet.
 - 1. Finish: Manufacturer's standard.
- F. Construction:
 - 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
 - 3. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
 - 4. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
 - 5. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 - 6. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
 - 7. Wind-Restraint Straps and Base Flange Attachment: Provide wind-restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to comply with wind-uplift requirements.
 - 8. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 - 9. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.3 EQUIPMENT SUPPORTS

- A. Internally reinforced perimeter metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, integral metal cant, and integrally formed structure-mounting flange at bottom.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Curbs Plus, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
 - 4. LMCurbs.
 - 5. Pate Company (The).
 - 6. Roof Products, Inc.
 - 7. Thybar Corporation.
- C. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- D. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.
- E. Stainless Steel: 0.0781 inch thick sheet.
 - 1. Finish: Manufacturer's standard.
- F. Construction:
 - 1. Curb Profile: Profile as indicated on Drawings compatible with roofing system.
 - 2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
 - 3. Nailer: Factory-installed continuous wood nailers 5-1/2 inches wide on top flange of equipment supports, continuous around support perimeter.
 - 4. Wind-Restraint Straps and Base Flange Attachment: Provide wind-restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to comply with wind-uplift requirements.
 - 5. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 - 6. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
 - 7. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.

2.4 ROOF HATCHES

- A. Metal roof-hatch units with lids and insulated single-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ACUDOR Products, Inc.
 - 2. Babcock-Davis.
 - 3. BILCO Company (The).
 - 4. Dur-Red Products.
 - 5. J. L. Industries, Inc.; Activar Construction Products Group, Inc.

6. Milcor by Duravent; Duravent Group.
7. Nystrom, Inc.
8. O'Keeffe's Inc.
9. Pate Company (The).

C. Type and Size:

1. Single-leaf lid, At least 30 by 36 inches but not less than size indicated on Drawings..

D. Loads: Minimum 40 lbf/sq. ft. external live load and 20 lbf/sq. ft. internal uplift load.

E. Hatch Material, Stainless Steel:

1. Thickness: Manufacturer's standard thickness for hatch size indicated.
2. Finish: Manufacturer's standard.

F. Construction:

1. Insulation: 2-inch- thick, polyisocyanurate board.
2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
5. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.

G. Hardware: Spring operators, hold-open arm, stainless steel spring latch with turn handles, stainless steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

H. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.

1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
2. Height: 42 inches above finished roof deck.
3. Material: Stainless steel.
4. Post: 1-5/8-inch- diameter pipe.
5. Finish: Manufacturer's standard.
 - a. Color: As selected by Architect from manufacturer's full range.

2.5 PIPE SUPPORTS

A. Fixed-Height Strut-Type Pipe Supports: Comply with DSA IR 16-13; Recycled rubber, UV-resistant pipe stand with 14-gauge galvanized steel struts accommodating slotted channel inserts; for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes, with load capacity up to 800 lbs. per foot. Height from roof surface to center of mass of supported component shall be less than 12 inches (actual product height is 4.8 inches). Lifetime warranty.

1. Basis-of-Design Product: Clearline Technologies Ltd., C-Port C-Series Channel Supports, or DSA-approved equal.

2.6 PREFORMED FLASHING SLEEVES

A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and slotted or perforated metal collar.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Custom Solution Roof and Metal Products, a division of Colony Heating.
 - b. Menzies Metal Products.
 - c. Thaler Metal Industries Ltd.
2. Metal: Aluminum sheet, 0.063 inch thick.

3. Diameter: As indicated on Drawings.
4. Finish: Manufacturer's standard.

B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Custom Solution Roof and Metal Products, a division of Colony Heating.
 - b. Menzies Metal Products.
 - c. Milcor by Duravent; Duravent Group.
 - d. Thaler Metal Industries Ltd.
2. Metal: Aluminum sheet, 0.063 inch thick.
3. Height: 13 inches.
4. Diameter: As indicated on Drawings.
5. Finish: Manufacturer's standard.

2.7 METAL MATERIALS

- A. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

2.8 UNDERLAYMENT

- A. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970/D1970M.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F or lower; ASTM D1970/D1970M.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ATAS International, Inc.
 - b. Carlisle WIP Products; a brand of Carlisle Construction Materials.
 - c. GCP Applied Technologies Inc.
 - d. Henry Company; a Carlisle company.
 - e. Palisade; Brand of Intertape Polymer Group (IPG).
 - f. Polyglass U.S.A., Inc.
 - g. Protecto Wrap Company.

- B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.9 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.
- C. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.
- D. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

- E. Fasteners: Roof accessory manufacturer's recommended fasteners, designed to comply with performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
 - 1. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
- F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- G. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- H. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- I. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- J. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.10 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA AMP 500, "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering, High-Temperature Sheet Underlayment:
 - 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
 - 2. Prime substrate if recommended by underlayment manufacturer.
 - 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 - 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.

5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

B. Slip Sheet: Install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than 4 inches.

3.3 INSTALLATION, GENERAL

A. Install roof accessories in accordance with manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended in writing by manufacturer's written installation instructions.

1. Coat concealed side of uncoated aluminum and stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

3.4 INSTALLATION OF ROOF ACCESSORIES

A. Roof Curb: Install each roof curb so top surface is level.

1. Attach curbs to wood nailer on roof deck with wood screws.
2. Weld curbs to metal roof deck.
3. Bolt curbs to concrete roof deck with lead shield expansion type inserts through each pre-drilled hole with 3/8 inch corrosion resistant steel bolts.
4. Anchor counter-flashing to wood nailer with lag screws and lead washers.

B. Equipment Support: Install equipment supports so top surfaces are level with each other.

C. Roof-Hatch:

1. Install roof hatch so top surface of hatch curb is level.
 - a. Attach curbs to wood nailer on roof deck with wood screws.
 - b. Weld curbs to metal roof deck.
 - c. Bolt curbs to concrete roof deck with lead shield expansion type inserts through each pre-drilled hole with 3/8 inch corrosion resistant steel bolts.
2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
3. Attach safety railing system to roof-hatch curb.
4. Attach ladder-assist post in accordance with manufacturer's written instructions.

D. Pipe Support: Comply with MSS SP-58 and DSA IR 16-13 . Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together. Install each support unit over 12 inch square cut of roof walk pad at a minimum of 6'-0" on center and at each change in direction of piping.

1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
- E. Preformed Flashing-Sleeve and Flashing-Pipe Portal: Secure flashing sleeve to roof membrane in accordance with flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane in accordance with roof membrane manufacturer's instructions.
- F. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.5 CLEANING AND PROTECTION

- A. On completion of installation, clean exposed surfaces in according with manufacturer's written instructions. Clean off excess sealants.
- B. Remove temporary protective coverings and strippable films as roof accessories are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof accessories in a clean condition during construction.
- C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 077200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.
 - 3. Penetrations in smoke barriers.
- B. Related Requirements:
 - 1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's standard detail sheets indicating approved classification listings by one of the testing agencies indicated below.
- B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency. Coordinate actual details with manufacturer's standard details.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Repair and replacement instructions for penetration firestopping.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Schedule: Final schedule indicating installer contact information, product information, firestopping hourly rating, firestopping locations and design designations used.
- D. Inspection Reports: Include inspection compliance reports from governing authorities and project inspectors, and approvals of any Engineering Judgments required by field conditions.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1. A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Installation Responsibility: Assign installation of penetration firestopping and fire-resistive joint systems to a single qualified firestop contractor. Coordinate products with any products installed by individual trades as specified in other Sections.
- C. Provide the following upon request:
 1. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.
- C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
 - b. Classification markings on penetration firestopping correspond to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."

2.2 MANUFACTURERS

- A. Single Source: Provide products from single manufacturer, except as noted.
- B. Manufacturers: Subject to compliance with requirements, provide penetration firestopping products by the following in coordination with authorized testing agency classification listings indicated on Drawings or as required for complete installation:
 - 1. Hilti, Inc., or comparable by one of the following:
 - a. 3M Fire Protection Products.
 - b. Specified Technologies Inc.
 - c. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - 2. If one of the comparable manufacturers is selected, it will be the contractor's responsibility to coordinate equal classification listings and/or Engineering Judgments for assemblies and details with the governing authority and any inspectors assigned to the Project.

2.3 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any. Provide additional component systems as may be required by manufacturers to satisfy compatibility requirement.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Fire-resistance-rated walls include fire walls, fire-barrier walls, and fire partitions.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Horizontal assemblies include floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
 - 2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 - 3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
 - 1. Permanent forming/damming/backing materials, including the following:

- a. Slag-wool-fiber or rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.4 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Firestop Putty Pads for Electrical Boxes: Listed intumescent moldable firestop putty pads. Product: Subject to compliance with requirements, provide one of the following:
 1. Hilti Corporation; CP 617 6" x 7" Putty Pad or CP 617L 7" x 7" Putty Pad.
 2. Kinetics Noise Control; IsoBacker.
 3. Specified Technologies Inc. (STI); SpecSeal Series SSP Putty Pad.
- J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.

3.3 INSTALLATION

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: University will engage a qualified testing agency to perform tests and inspections according to ASTM E2174. Inspections shall comply with CBC Section 1705.17, and CBC Section 1705.18 as applicable.
1. Inspect completed firestop installation in accordance with ASTM E2174. Perform destructive testing as deemed necessary, and in accordance with ASTM E2174 to verify installation meets the requirements of the UL Listing.

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SCHEDULE

- A. General: Refer to Drawings for fire rated assemblies.
1. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
 2. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Listed Building Products" under "Firestop Systems."
 3. Where FM Approval-approved systems are indicated, they refer to design numbers listed in FM Approval's "Approval Guide" under "Wall and Floor Penetration Fire Stops."
- B. Firestopping at fire rated openings for conduit and cable trays:
1. Through Penetration Firestopping of Fire Rated Assemblies: ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings not less than 1-hour.
 - a. Wall Penetrations: Fire F-Ratings not less than 1-hour.
 - b. Floor Penetrations: Fire F-Ratings and temperature T-Ratings not less than 1-hour.
 2. Through Penetration Firestopping of Non-Fire Rated Floor Assemblies: Materials to resist free passage of flame and products of combustion.
 - a. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - b. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

END OF SECTION

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Joints at exterior curtain-wall/floor intersections.
 - 2. Joints in smoke barriers.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers and for wall identification.
 - 2. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's standard detail sheets indicating approved classification listings by one of the testing agencies indicated below.
- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.
- B. Product Schedule: Final schedule indicating installer contact information, product information, firestopping hourly rating, firestopping locations and design designations used.
- C. Inspection Reports: Include inspection compliance reports from governing authorities and project inspectors, and approvals of any Engineering Judgments required by field conditions.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."
 - 1. A firm experienced in installing joint firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its joint firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

- B. Installation Responsibility: Assign installation of joint firestopping systems and penetration firestopping to a single qualified firestop contractor. Coordinate products with any products installed by individual trades as specified in other Sections.
- C. Provide the following upon request:
 - 1. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."

2.2 MANUFACTURERS

- A. Single Source: Provide products from single manufacturer, except as noted.
- B. Manufacturers: Subject to compliance with requirements, provide joint firestopping products by the following in coordination with authorized testing agency classification listings indicated on Drawings or as required for complete installation:
 - 1. Hilti, Inc., or comparable by one of the following:
 - a. 3M Fire Protection Products.
 - b. Specified Technologies, Inc.
 - c. Thermafiber, Inc.; an Owens Corning company.
 - d. Tremco, Inc. Specified Technologies Inc.
 - 2. If one of the comparable manufacturers is selected, it will be the contractor's responsibility to coordinate equal classification listings and/or Engineering Judgments for assemblies and details with the governing authority and any inspectors assigned to the Project.

2.3 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.
 - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E 2307.
 - 1. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
- D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg .
 - 1. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.
- E. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
 - 1. Sealant shall have a VOC content of 250 g/L or less.
 - 2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.

- B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

- A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
 - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.
- B. Inspecting Agency: University will engage a qualified testing agency to perform tests and inspections according to ASTM E 2393. Inspections shall comply with CBC Section 1705.17, and CBC Section 1705.18 as applicable.
 - 1. Inspect completed firestop installation in accordance with ASTM E2393. Perform destructive testing as necessary, and in accordance with ASTM E393 to verify installation meets the requirements of the UL Listing.
- C. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

3.5 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.6 JOINT FIRESTOPPING SYSTEM SCHEDULE

- A. General: Refer to Drawings for fire rated assemblies.
 - 1. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.
 - 2. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Listed Building Products" under product category Firestop Systems.

END OF SECTION

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Mildew-resistant joint sealants.
5. Joint sealant backing.

B. Related Requirements:

1. Section 072726 "Fluid-Applied Membrane Air Barriers" for sealants associated with weather barriers.
2. Section 076200 "Sheet Metal Flashing and Trim;" for joints sealants and butyl sealant tape used in conjunction with sheet metal fabrications and metal flashing.
3. Section 078443 "Joint Firestopping" for sealing joints in fire-resistance-rated construction.
4. Section 079219 "Acoustical Joint Sealants" for joint sealants used in sound-rated assemblies.
5. Section 088000 "Glazing" for glazing sealants.
6. Section 092900 "Gypsum Board" for sealing perimeter joints.
7. Section 093000 "Tiling" for sealing tile joints.
8. Section 095100 "Suspended Acoustical Ceilings" for sealing edge moldings at perimeters with acoustical sealant.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:
 - a. Each kind of sealant and joint substrate indicated.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated, unless otherwise indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 1. Joint-sealant application, joint location, and designation.
 2. Joint-sealant manufacturer and product name.
 3. Joint-sealant formulation.
 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- B. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- C. Field-Adhesion Test Reports: For each sealant application tested.
- D. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.
 1. If SWRI validation certificates cannot be obtained for sealants specified and substrates sealants will be adhered to, provide test reports by third party testing agency showing compliance.
- E. Sample warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
- C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
 2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
- D. Mockups: Install sealants in mockups of assemblies specified in other Sections that are indicated to receive sealants specified in this Section. Use materials and installation methods specified in this Section.
- E. Provide the following upon request:
1. Qualification Data: For qualified Installer and testing agency.
 2. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
 3. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements. Provide if requested and if SWRI certificates are not available.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

- A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period, Polyurethane: Five years from date of Substantial Completion.
 2. Warranty Period, Silicone: Twenty years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
 - 1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Sealant JS-S1 - Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following products that has a validation certificate from the Sealant, Waterproofing and Restoration Institute (SWRI).
 - a. Dowsil 791
 - b. Dowsil 795
 - c. Momentive Silpruf SCS2000
 - d. Tremco Spectrum 2
- B. Sealant JS-S2 - Single-Component, Nonsag, Non-Staining, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following products that has a validation certificate from the Sealant, Waterproofing and Restoration Institute (SWRI).
 - a. Dowsil 756 SMS
 - b. Momentive Silpruf NB SCS 9000
 - c. Tremco Spectrum 3
- C. Sealant JS-S3 - Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.

1. Products: Subject to compliance with requirements, provide on of the following products that has a validation certificate from the Sealant, Waterproofing and Restoration Institute (SWRI).
 - a. Dowsil 790
 - b. Momentive Silpruf LM SCS2700
 - c. Tremco Spectrum 1

2.3 WEATHER BARRIER SEALANTS

- A. Sealant JS-W1 - Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT; tested and marketed specifically for sealing air barrier and vapor retarder sheets to common building materials, such as aluminum, vinyl, PVC, powder coat, paint and fluoropolymer coatings; UV resistant..
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Dowsil 758.

2.4 URETHANE JOINT SEALANTS

- A. Sealant JS-U1 - Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type M, Grade P, Class 25, for Use T and I.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. LymTal International, Inc.; Iso-Flex 880 GB.
 - b. May National Associates, Inc.; Bondaflex PUR 2 SL.
 - c. Tremco Incorporated; Vulkem 445SSL or Vulkem 45SSL.
- B. Sealant JS-U2 - Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; MasterSeal NP 2.
 - b. LymTal International, Inc.; Iso-Flex 881 or Iso-Flex 885 SG.
 - c. May National Associates, Inc.; Bondaflex PUR 2 NS.
 - d. Pecora Corporation; Dynatred.
 - e. Sika Corporation, Construction Products Division; Sikaflex - 2c NS or Sikaflex - 2c EZ Mix.
 - f. Tremco Incorporated; Vulkem 227.

2.5 LATEX JOINT SEALANTS

- A. Sealant JS-L1 - Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolac.
 - b. Bostik, Inc.; Chem-Calk 600.
 - c. DAP Products Inc.; ALEX Ultra 230.
 - d. May National Associates, Inc.; Bondaflex 600 or Bondaflex Sil-A 700.
 - e. Pecora Corporation; AC-20 + Silicone.
 - f. Tremco Incorporated; Tremflex 834.

2.6 BUTYL RUBBER BASED JOINT SEALANTS

- A. Sealant JS-B1 - Butyl-Rubber-Based Joint Sealant: ASTM C 1311.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bostik, Inc.; Chem-Calk 300.
 - b. Pecora Corporation; BC-158.
 - c. Tremco Incorporated; Tremco Butyl Sealant.

2.7 MILDEW-RESISTANT JOINT SEALANTS

- A. Sealant JS-M1 - Mildew-Resistant, Single-Component, Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Omniplus.
 - b. Dow Corning Corporation; 786 Mildew Resistant.
 - c. GE Advanced Materials - Silicones; Sanitary SCS1700.
 - d. May National Associates, Inc.; Bondaflex Sil 100 WF.
 - e. Pecora Corporation; 898.
 - f. Tremco Incorporated; Tremsil 200 Sanitary.

2.8 ACOUSTICAL JOINT SEALANTS

- A. Specified in Section 079219 "Acoustical Joint Sealants."

2.9 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.10 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Do not extend exterior sealants and primers into building interior (that is, inside the weatherproofing system) unless first verifying compliance with VOC requirements.
- D. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

- F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces. Water-based tooling agents are unacceptable.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
 - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 - 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

- B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces; Type JS-U1 or JS-U2.
1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and exterior horizontal nontraffic surfaces; .
1. Joint Locations:
 - a. Control and expansion joints in unit masonry: JS-S2
 - b. Joints between metal panels: JS-S1 or JS-S2
 - c. Joints between different materials listed above: JS-S2
 - d. Perimeter joints between materials listed above and frames of exterior openings: JS-S2, JS-S3 where required for additional movement. JS-S1 is acceptable only if materials adjacent to aluminum framing are non-staining.
 - e. Control and expansion joints in overhead surfaces: JS-S2.
- C. Joint-Sealant Application: Exterior weather barrier joints; Type JS-S1, JS-S2, JS-S3, or JS-W1.
- D. Joint-Sealant Application: Interior joints in horizontal traffic surfaces; Type JS-U1 or JS-U2.
1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring, except in wet areas.
 - c. Other joints as indicated.
- E. Joint-Sealant Application: Interior joints in vertical surfaces and interior horizontal nontraffic surfaces; Type JS-L1.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Vertical joints on exposed surfaces of walls and partitions.
 - d. Perimeter joints between interior wall surfaces and frames of interior openings .
 - e. Other joints as indicated.
- F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces; Type JS-M1.
1. Joint Sealant Location:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints in wet areas and where indicated.
 - c. Other joints as indicated.
- G. Joint Sealant Application: Joints in sound-rated assemblies.
1. Comply with Section 079219 "Acoustical Joint Sealants."

END OF SECTION

SECTION 079219 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical joint sealants.
- B. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for nonacoustical applications.

1.2 DEFINITION

- A. Acoustic Joint Sealant: "Acoustic Joint Sealant or Spray: Material or combination of materials used to achieve specified acoustical rating of non-fire-rated assembly by providing an effective barrier against sound transmission through construction joint and through penetration openings."

1.3 ACTION SUBMITTALS

- A. Product Data: For each acoustical joint sealant.
- B. Samples for Verification: For each kind and color of acoustical joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Acoustical-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Provide the following upon request:
 - 1. Product Test Reports: For each kind of acoustical joint sealant, for tests performed by a qualified testing agency.

1.5 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.
1. Sealant shall have a VOC content of 250 g/L or less.
 2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Accumetric LLC; BOSS 826 Acoustical Sound Sealant.
 - b. GE Construction Sealants; RCS20 Acoustical.
 - c. Tremco, Incorporated; Tremco Acoustical Sealant.
 - d. USG Corporation; SHEETROCK Acoustical Sealant.
 2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.
- B. Sprayed Sound Seal: Paintable acrylic latex spray designed for static or minimally dynamic linear joints or gaps in non rated barriers where indicated on Drawings.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
 - a. Specified Technologies, Inc. (STI Firestop); SpecSeal SNS Smoke 'N' Sound Spray, or equal by one of the following:
 - 1) Tremco Incorporated
 - 2) RectorSeal LLC
 - 3) Or equal.
 2. Fire-Resistance: ASTM E 84, Class A
 3. Wet Film Thickness: Not less than 1/4 inch, unless otherwise directed by manufacturer to suit conditions.
 4. Air Leakage: UL2079 or UL1479; Not more than 1.0 cfm
 5. STC Rating: ASTM E 90; Not less than 59.

2.3 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

- A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.
- B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant or spray sealant to suit conditions. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C 919, ASTM C 1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.
- C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes hollow-metal work.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
 - 2. Division 08 Sections for "Glazing" for glass installed in hollow-metal doors and frames.
 - 3. Section 099600 "High-Performance Coatings" for painting of hollow metal doors and frames.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.
 - 9. Details of conduit and preparations for power, signal, and control systems.
- C. Samples for Verification:
 - 1. For "Doors" and "Frames" subparagraphs below, prepare Samples approximately 8 by 10 inches to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
- D. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.5 QUALITY ASSURANCE

- A. Provide the following upon request.
 - 1. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.
 - 2. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ceco Door; ASSA ABLOY.
 - 2. Concept Frames, Inc.
 - 3. Curries Company; ASSA ABLOY.
 - 4. Custom Metal Products.
 - 5. Hollow Metal Xpress.
 - 6. Republic Doors and Frames.
 - 7. Steelcraft; an Allegion brand.
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 without artificial bottom seal, and installed in compliance with NFPA 105.
 - 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, and elsewhere when required by governing code, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- B. Thermally Rated Door Assemblies: Provide exterior door assemblies with U-factor of not more than 0.38 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.

- C. Air Infiltration: Provide exterior door and frame assemblies with the following air leakage limitations when tested in accordance with ASTM E283:
 - 1. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft..
 - 2. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

2.3 INTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors: SDI A250.8, Level 2. At interior locations.
 - 1. Physical Performance: Level B according to SDI A250.4.
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch.
 - d. Edge Construction: Model 2, Seamless.
 - e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
 - 3. Exposed Finish: Shop prime and paint.

2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards as modified and indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3. At exterior locations.
 - 1. Physical Performance: Level A according to SDI A250.4. Provide exterior doors and frames with a maximum air leakage of 0.3 CFM/SF when tested at 6.24 psf pressure differential based on energy code requirements as tested according to ASTM E283.
 - 2. Thermal Characteristics: Provide exterior doors and frames to meet Performance Requirements, with or without thermal break.
 - 3. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
 - d. Edge Construction: Model 2, Seamless.
 - e. Core: Polystyrene, Polyurethane, or Polyisocyanurate.
 - 1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
 - 4. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum A60 coating.
 - b. Construction: Full profile welded.
 - 5. Exposed Finish: Shop prime and paint.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
 - 2. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.6 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- E. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- G. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- I. Glazing: Comply with requirements in Section 088000 "Glazing" and Section 088813 "Fire-Resistant Glazing and Framing."
- J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 ACCESSORIES

- A. Louvers: Provide louvers for interior doors, where indicated, which comply with SDI 111C, with blades or baffles formed of 0.020-inch- thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame. Verify with Door Schedule on Drawings.
 - 1. Sightproof Louver, as occurs: Stationary louvers constructed with inverted-V or inverted-Y blades.

2. Fire-Rated Automatic Louvers, as occurs: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.

2.8 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
 2. Fire Door Cores: As required to provide fire-protection ratings indicated.
 3. Vertical Edges for Single-Acting Doors: Provide beveled or square edges at manufacturer's discretion.
 4. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.
 5. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
 6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 7. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
 4. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - b. Compression Type: Not less than two anchors in each frame.
 - c. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
 5. Head Anchors: Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
 6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

- b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- 7. Terminated Stops: Terminate stops 6 inches above finish floor with a 90-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.
 - 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work. Grind smooth.
 - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 - 4. Provide loose stops and moldings on inside of hollow-metal work.
 - 5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 - 6. Provide fire-rated assembly where indicated.

2.9 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and topcoats regardless of prolonged exposure.
- B. Paint doors and frames according to Section 099600 "High-Performance Coatings."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
 - 4. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Steel Doors:
 - a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
 - c. At Bottom of Door: 3/4 inch plus or minus 1/32 inch.
 - d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - 3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.
- D. Glazing: Comply with installation requirements in Division 08 glass Sections and with hollow-metal manufacturer's written instructions.
 - 1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- C. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

SECTION 081216 - ALUMINUM FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Interior aluminum door frames and glazing frames.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, fire-resistance rating, and finishes.
- B. Shop Drawings: For aluminum frames:
1. Include elevations, sections, and installation details for each wall-opening condition.
 2. Include details for each frame type, including dimensioned profiles and metal thicknesses.
 3. Include locations of reinforcements and preparations for hardware.
 4. Include details of anchorages, joints, field splices, connections, and accessories.
 5. Include details of moldings, removable stops, and glazing.
- C. Samples for Verification: For each type of the following products:
1. Framing Member and Finish: 12 inches long. Include trim.
 2. Corner Fabrication and Finish: 12-by-12-inch- long, full-size window corner, including full-size sections of extrusions with factory-applied color finish.
- D. Product Schedule: For aluminum frames. Use same designations indicated on Drawings. Coordinate with door hardware schedule and glazing.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum frames to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Avalon International Aluminum, LLC
 2. Versatrac Frames; a division of American Door Products Inc.
 3. Western Integrated Materials, Inc.
 4. Wilson Partitions; a division of Acradia, Inc.
- B. Source Limitations: Obtain aluminum frames from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Frames: Frames for fire-rated door assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252.

1. Oversize Fire-Rated Frames: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that frames comply with standard construction requirements for tested and labeled fire-rated frames except for size.
2. Frames for Smoke- and Draft-Control Assemblies: Tested in accordance with UL 1784 and installed in compliance with NFPA 105.
 - a. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg.

2.3 INTERIOR ALUMINUM DOOR FRAMES AND GLAZING FRAMES

- A. Aluminum Framing: ASTM B221, with alloy and temper required to suit structural and finish requirements, and not less than 0.062 inch thick.
- B. Door Frames: Extruded aluminum, reinforced for hinges, strikes, and closers.
- C. Glazing Frames: Extruded aluminum, for indicated glass thickness.
- D. Trim: Extruded aluminum, not less than 0.062 inch thick; removable, snap-in casing trim glazing stops door stops, without exposed fasteners.
 1. Trim Style: As selected by Architect from manufacturer's available sizes and profiles.
- E. Doors: As specified in Section 081416 "Flush Wood Doors."
- F. Frame and Trim Finish: Color anodic

2.4 ACCESSORIES

- A. Fasteners: Aluminum, nonmagnetic, stainless steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. Door Silencers: Manufacturer's standard continuous mohair, wool pile, or vinyl seals in black color.
- C. Smoke Seals: Intumescent strip or fire-rated gaskets in black.
- D. Glazing Gaskets: Manufacturer's standard extruded or molded rubber or plastic, to accommodate glazing thickness indicated; in black.
- E. Glass: As specified in Section 088000 "Glazing."
- F. Door Hardware: As selected by Architect from manufacturer's full range. As specified in Section 087100 "Door Hardware."

2.5 FABRICATION

- A. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted and mitered connections.
- B. Factory prepare aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, in accordance with the Door Hardware Schedule and templates furnished as specified in Section 087100 "Door Hardware."
 1. Locate hardware cutouts and reinforcements as required by fire-rated label for assembly.
 2. At frames receiving locks, provide additional internal reinforcement as needed to prevent excessive frame deflection.
- C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.

1. Locate removable stops on the inside of spaces accessed by keyed doors.

D. Fabricate components to allow secure installation without exposed fasteners.

2.6 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker as standard with manufacturer.

1. Color: Dark bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that wall thickness does not exceed standard tolerances allowed by throat size of indicated aluminum frame.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install aluminum frames plumb, rigid, properly aligned, and securely fastened in place; in accordance with manufacturer's written instructions.

1. At fire-protection-rated openings, install fire-rated frames in accordance with NFPA 80.

B. Install frame components in the longest possible lengths with no piece less than 48 inches; components 96 inches or shorter shall be one piece.

1. Fasten to suspended ceiling grid on maximum 48-inch centers, using sheet metal screws or other fasteners approved by frame manufacturer.

2. Use concealed installation clips to produce tightly fitted and aligned splices and connections.

3. Secure clips to extruded main-frame components and not to snap-in or trim members.

4. Do not leave screws or other fasteners exposed to view when installation is complete.

C. Glass: Install glass in accordance with Section 088000 "Glazing" and aluminum-frame manufacturer's written instructions.

D. Doors: Install doors aligned with frames and fitted with required hardware.

E. Door Hardware: Install in accordance with Section 087100 "Door Hardware" and aluminum-frame manufacturer's written instructions.

3.3 ADJUSTING

A. Inspect installation, correct misalignments, and tighten loose connections.

- B. Doors: Adjust doors to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly, and lubricate as recommended by manufacturer.
- C. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended in writing by frame manufacturer and in accordance with AAMA 609 & 610.

END OF SECTION

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Factory fitting flush wood doors to frames and factory machining for hardware.
- B. Related Requirements:
 - 1. Section 088000 "Glazing" for glass view panels in flush wood doors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
 - 4. Undercuts.
 - 5. Requirements for veneer matching.
 - 6. Doors to be factory finished and finish requirements.
 - 7. Fire-protection ratings for fire-rated doors.
- C. Samples for Verification:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
 - 2. Plastic laminate, 6 inches square, for each color, texture, and pattern selected.
 - 3. Frames for light openings in flush wood doors, 6 inches, for each material, type, and finish required.

1.3 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.4 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies complies with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 - 1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.
- B. Provide the following upon request:
 - 1. Qualification Data: For door inspector.
 - a. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 - b. Submit copy of DHI's Fire and Egress Door Assembly Inspector (FDAI) certificate.
 - 2. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following
 - 1. ABS Manufacturing - Doormerica Products
 - 2. Lambton Doors.
 - 3. Oshkosh Door Company.
 - 4. VT Industries Inc
- B. Source Limitations:
 - 1. Obtain flush wood doors from single manufacturer.
 - 2. Source Limitations: Obtain wood veneer flitches from the same qualified woodworking firm responsible for production of flush wood paneling and wood-veneer-faced architectural cabinets.

2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with ANSI/WDMA I.S. 1A.
 - 1. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.
- B. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.
- C. WDMA I.S.1-A Performance Grade:

1. Heavy Duty unless otherwise indicated.
 - a. Extra Heavy Duty: Classrooms, public toilets, janitor's closets, assembly spaces, maintenance rooms, and exits.
 - b. Standard Duty: Closets (not including janitor's closets) and similar low-use doors.

- D. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
 3. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 4. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 5. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

- E. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

- F. Particleboard-Core Doors:
 1. One of the following:
 - a. Particleboard: ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde.
 2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
 3. Provide doors with structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.
 - a. Structural-Composite-Lumber Properties: WDMA I.S.10.
 - 1) Screw Withdrawal, Face: 700 lbf.
 - 2) Screw Withdrawal, Edge: 400 lbf.

- G. Mineral-Core Doors:
 1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - a. Screw-Holding Capability: 550 lbf per WDMA T.M.-10.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:
 1. ANSI/WDMA I.S. 1A Grade: Premium.
 2. Species and Cut: White Oak, flat cut
 3. Match between Veneer Leaves: Book. Match color and size.
 4. Assembly of Veneer Leaves on Door Faces: Center-balance match.

5. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
6. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
7. Transom Match: Continuous match.
8. Blueprint Match: Not required. Provide pleasing match.
9. Exposed Vertical and Top Edges: Same species as faces or a compatible species - edge Type A.
10. Core: Particleboard.
11. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.
12. Sound-control: Provide doors with STC ratings indicated, but not less than rating of adjoining wall assembly as indicated on Drawings.

2.4 LIGHT FRAMES AND LOUVERS

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
 1. Wood Species: Same species as door faces or Species compatible with door faces.
 2. Profile: Flush rectangular beads.
 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
- B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.
- C. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.
 1. Wood Species: Species compatible with door faces.
- D. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Air Louvers Inc.
 - b. Anemostat; a Mestek company.
 - c. L & L Louvers, Inc.
 - d. Louvers & Dampers, Inc.; a Mestek company.
 - e. McGill Architectural Products.
 2. Metal and Finish: Hot-dip galvanized steel, 0.040 inch thick, with baked-enamel- or powder-coated finish.

2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 1. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

- C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
 - 1. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
- D. Openings: Factory cut and trim openings through doors.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
 - 3. Louvers: Factory install louvers in prepared openings.

2.6 SHOP PRIMING

- A. Doors for Transparent Finish: Shop prime faces and all four edges with stain (if required), other required pretreatments, and first coat of finish. Seal edges of cutouts and mortises with first coat of finish.

2.7 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors that are indicated to receive transparent finish.
- C. Transparent Finish:
 - 1. ANSI/WDMA I.S. 1A Grade: Premium
 - a. Finish: One of the following as standard with manufacturer:
 - 1) TR-4 Conversion Varnish.
 - 2) TR-6 Catalyzed Polyurethane.
 - 3) TR-8 UV Cured Acrylated Polyester/Urethane.
 - 2. Staining: Match Architect's sample.
 - 3. Sheen: Matte (Satin), 31-45 gloss units measured on 60-degree gloss meter per ASTM D523.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."

- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 - 1. Install fire-rated doors according to NFPA 80.
 - 2. Install smoke- and draft-control doors according to NFPA 105.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.
- B. Related Requirements:
 - 1. Division 23 "Air Duct Accessories" for heating and air-conditioning duct access doors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches in size.
- C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

2.2 INTERIOR ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Concealed Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ACUDOR Products, Inc.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Karp Associates, Inc.
 - d. Larsens Manufacturing Company.
 - e. Milcor; a division of Hart & Cooley, Inc.
 - f. Nystrom.
 - 2. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
 - 3. Locations: Wall and ceiling.
 - 4. Door Size: Smallest possible to allow access to device, but not less than 12 inches square.
 - 5. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory primed; except provide stainless steel in wet areas.
 - a. Stainless Steel Sheet for Door: Nominal 0.062 inch, 16 gage, ASTM A480/A480M No. 4 finish.
 - 6. Frame Material: Same material and thickness as door.
 - 7. Latch and Lock: Cam latch, screwdriver operated.
- B. Recessed Access Doors with Concealed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ACUDOR Products, Inc.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Karp Associates, Inc.
 - d. Larsens Manufacturing Company.
 - e. Milcor; a division of Hart & Cooley, Inc.
2. Nystrom. Description: Door face recessed 5/8 inch for gypsum board infill; with concealed flange for gypsum board installation and concealed hinge.
3. Locations: Wall.
4. Door Size: Smallest possible to allow access to device, but not less than 12 inches square.
5. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory primed.
6. Frame Material: Same material and thickness as door.
7. Latch and Lock: Cam latch, screwdriver operated.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

- A. Fire-Rated, Flush Access Doors with Concealed Flanges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ACUDOR Products, Inc.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Karp Associates, Inc.
 - d. Larsens Manufacturing Company.
 - e. Milcor; a division of Hart & Cooley, Inc.
 - f. Nystrom.
 2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
 3. Locations: Interior fire-rated walls and fire-rated ceilings.
 4. Optional Features: Upward-opening doors for ceilings
 5. Door Size: Minimal, as indicated or required to access device or fixture.
 6. Fire-Resistance Rating: Not less than that of adjacent construction.
 7. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage, factory primed.
 8. Latch and Lock: Self-closing, self-latching door hardware, screwdriver operated.

2.4 SPECIALTY DOORS

- A. Vent Fan Coil Door:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ACUDOR Products, Inc.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Karp Associates, Inc.
 - d. Larsens Manufacturing Company.
 - e. Milcor; a division of Hart & Cooley, Inc.
 - f. Nystrom.
 2. Basis-of-Design Product:
 - a. Acudor Model VFCD, or equal.
 3. Description: Stacked design with fully removable door design. Flush louver punched bottom door panel with air filter brackets.
 4. Size: As indicated.
 5. Material: 18 gauge steel; satin coated.
 - a. Finish: 5-stage iron phosphate preparation with baked enamel prime coat.
 6. Door: Recessed 5/8 inch to accept gypsum board panel; acoustically gasketed four sides.
 7. Frame: Drywall taping bead on all sides.

8. Hinge: Concealed.
9. Latch: Cylinder lock and key, coordinated with Section 087100 "Door Hardware."

2.5 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Frame Anchors: Same material as door face.
- D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.6 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.
- E. Latch and Lock Hardware:
 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 2. Keys: Furnish two keys per lock and key all locks alike.

2.7 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in NFPA 80.

3.4 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION

SECTION 083313 - COILING COUNTER DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Counter door assemblies.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for door-opening framing and corner guards.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type and size of coiling counter door and accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
 - 3. Include description of automatic closing device and testing and resetting instructions.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 4. Show locations of controls, locking devices, and other accessories.
 - 5. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
 - 1. Curtain slats.
 - 2. Bottom bar with sensor edge.
 - 3. Locking device(s).
 - 4. Include similar Samples of accessories involving color selection.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For coiling counter doors to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain coiling counter doors from single source from single manufacturer.
 - 1. Obtain operators and controls from coiling counter door manufacturer.

2.2 COUNTER DOOR ASSEMBLY

- A. Counter Door: Coiling counter door formed with curtain of interlocking metal slats.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cookson; a CornellCookson company.
 - b. Cornell; a CornellCookson company.
 - c. McKeon Rolling Steel Door Company, Inc.
 - d. Overhead Door Corporation.
- B. Operation Cycles: Door components and operators capable of operating for not less than 20,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
 - 1. Include tamperproof cycle counter.
- C. STC Rating: 26.
- D. Door Curtain Material: Stainless steel.
- E. Bottom Bar: Manufacturer's standard continuous channel or tubular shape, fabricated stainless steel and finished to match door.
- F. Curtain Jamb Guides: Stainless steel with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.
- G. Hood: Match curtain material and finish.
- H. Sill Configuration: As indicated.
- I. Locking Devices: Equip door with locking device assembly.
 - 1. Locking Device Assembly: Cremone-type, both jamb sides locking bars, operable from inside with thumbturn outside with cylinder.
- J. Door Finish:
 - 1. Stainless Steel Finish: ASTM A480/A480M No. 4 (polished directional satin).
 - 2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.3 DOOR CURTAIN MATERIALS AND FABRICATION

- A. Door Curtains: Fabricate coiling counter door curtain of interlocking metal slats in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Stainless Steel Door Curtain Slats: ASTM A240/A240M or ASTM A666, Type 304; sheet thickness of 0.025 inch; and as required.
 2. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.
1. Removable Posts and Jamb Guides: Manufacturer's standard.

2.4 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Stainless Steel: 0.025-inch- thick, stainless steel sheet, Type 304, complying with ASTM A240/A240M or ASTM A666.
- B. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.

2.5 LOCKING DEVICES

- A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
1. Lock Cylinders: As specified in Section 087100 "Door Hardware".
 2. Keys: Three for each cylinder.
- B. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.6 COUNTERBALANCE MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless or welded carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.7 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-rewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
1. Comply with NFPA 70.
 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door Operator Location(s): Operator location indicated for each door.
1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
- D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated for each door assembly.
1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
- E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.
1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
1. Type: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
- H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Directional Satin Finish: ASTM A480/A480M No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install coiling counter doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; in accordance with manufacturer's written instructions and as specified.
- B. Install coiling counter doors, hoods, controls, and operators at the mounting locations indicated for each door.

3.3 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust seals to provide tight fit around entire perimeter.

3.4 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service is to include 12 months' full maintenance by skilled employees of coiling-door Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies are to be manufacturer's authorized replacement parts and supplies.
1. Perform maintenance, including emergency callback service, during normal working hours.
 2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain coiling counter doors.

END OF SECTION 083313

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes aluminum-framed entrance and storefront systems.
- B. Related Requirements:
 - 1. Section 081216 "Aluminum Frames" for interior aluminum framing with wrap-around frames.
 - 2. Section 084316 "Interior Aluminum-Framed Storefronts" for nonthermal interior aluminum storefront framing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 - 4. Include point-to-point wiring diagrams showing the following:
 - a. Power requirements for each electrically operated door hardware.
 - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.

- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- C. Provide the following upon request:
 - 1. Qualification Data:
 - a. For Installer.
 - 2. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
 - a. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
 - 3. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified testing agency.
 - 4. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period:
 - a. Exterior: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, and curtain walls, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- B. Structural Loads:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
- C. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 3. Cantilever Deflection: Limited to 2l/175 at unsupported cantilevers.
- D. Structural: Test in accordance with ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- E. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. .
- F. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft..
 2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- G. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

- H. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have a total system U-factor of not more than 0.4538 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100, based on center-of-glass (COG) values indicated in Section 088000.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a total system solar heat gain coefficient of no greater than 0.23 as determined in accordance with NFRC 200 based on center-of-glass (COG) values indicated in Section 088000.
 3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. of fixed wall area as determined in accordance with ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft..
 4. Condensation Resistance: Design the wall and its components to not develop any visible interior condensation on framing members or glazing when the exterior air dry bulb temperature is 95 deg F and the interior air dry bulb temperature is 65 deg F and with a 50 percent relative humidity.
 - a. Provide independent laboratory test reports based on AAMA 1503.1, confirming wall system performance to at least the above criteria.
 - b. If independent laboratory test reports are unavailable to verify thermal performance, provide computer analysis using THERM 5 and Windows 5 software as developed by Lawrence Berkeley National Laboratory. Include in the analysis at least all principle mullions for sill, jamb, and head conditions for vision lights and spandrel areas.
- I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 - c. Interior Ambient-Air Temperature: 72 deg F.

2.3 STOREFRONT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Arcadia, Inc.
 2. Kawneer North America, an Arconic company.
 3. Oldcastle BuildingEnvelope.
- B. Basis-of-Design: Kawneer TriFab VG 451T
- C. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Exterior Framing Construction: Thermally broken.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Front.
 4. Finish: High-performance organic finish.
 5. Fabrication Method: Field-fabricated stick system.
 6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 7. Steel Reinforcement: As required by manufacturer.
- D. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

- E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
 - 1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: Manufacturer's standard.
 - 2. Door Design: As indicated.
 - 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.
 - 4. Finish: Match adjacent storefront framing finish.

2.5 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

2.6 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's silicone sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

2.7 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.8 ACCESSORIES

- A. Automatic Door Operators: Section 087113 "Automatic Door Operators."
- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 2. Reinforce members as required to receive fastener threads.
 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- D. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
- F. Rigid PVC Filler.

2.9 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Physical and thermal isolation of glazing from framing members.
 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 5. Provisions for field replacement of glazing from exterior or interior.
 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
1. At exterior doors, provide compression weather stripping at fixed stops.
- F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 2. At exterior doors, provide weather sweeps applied to door bottoms.
- G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- H. After fabrication, clearly mark components to identify their locations in Project in accordance with approved Shop Drawings.

2.10 ALUMINUM FINISHES

- A. High-Performance Organic Finish, Two-or Three- Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear top coat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Color and Gloss: As indicated on Drawings.
 - a. Basis-of-Design Product: Kawneer Permafluor with clear topcoat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions and approved Shop Drawings.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 088000 "Glazing."

3.4 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS

- A. Install entrance doors to produce smooth operation and tight fit at contact points.
 - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.5 ERECTION TOLERANCES

- A. Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
 - 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 - 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 - 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
 - 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: District will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
 - 1. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.09 cfm/sq. ft., of fixed wall area when tested in accordance with ASTM E 783 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft..
 - a. Test Area: One bay wide, but not less than 30 feet, by one story of glazed aluminum curtain wall.
 - b. Perform a minimum of three tests in areas as directed by Architect.
 - c. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
 - 2. Water Penetration: Areas shall be tested in accordance with ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.
 - a. Test Area: One bay wide, but not less than 30 feet, by one story of glazed aluminum curtain wall.
 - b. Perform a minimum of three tests in areas as directed by Architect.
 - c. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
- C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 084316 - INTERIOR ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes interior aluminum-framed storefront systems.
- B. Related Requirements:
 - 1. Section 081216 "Aluminum Frames" for interior aluminum wrap-around framing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For aluminum-framed storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed storefronts to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- B. Provide the following upon request:
 - 1. Product Test Reports: For aluminum-framed storefronts, for tests performed by a qualified testing agency.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including, but not limited to, excessive deflection.

- b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
 - c. Cracking, peeling, or chipping.
 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Arcadia, Inc.
 2. Kawneer North America, an Arconic company.
 3. Oldcastle BuildingEnvelope.
- B. Basis-of-Design: Kawneer TriFab 400
- C. Source Limitations: Obtain all components of interior aluminum-framed storefront system, including accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Seismic Performance: Aluminum-framed storefronts shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

2.3 ALUMINUM-FRAMED STOREFRONT SYSTEMS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Interior Framing Construction: Nonthermal.
 2. Glazing System: Retained mechanically with gaskets on four sides; 1-3/4 inch by 4 inch.
 3. Glazing Plane: Front.
 4. Finish: Color anodic finish.
 5. Fabrication Method: Field-fabricated stick system.
 6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 7. Steel Reinforcement: As required by manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Comply with Section 088000 "Glazing."
- C. Glazing Sealants: As recommended by manufacturer and complying with Section 088000 "Glazing."
 - 1. Sealant shall have a VOC content of 250 g/L or less.
 - 2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

2.6 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
- C. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
- D. Rigid PVC Filler.

2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Accommodations for mechanical movements of glazing and framing to maintain required glazing edge clearances.
 4. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. After fabrication, clearly mark components to identify their locations in Project in accordance with approved Shop Drawings.

2.8 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker as standard with manufacturer.
1. Color: Dark bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.

- J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 088000 "Glazing."

3.4 ERECTION TOLERANCES

- A. Install aluminum-framed storefronts to comply with the following maximum tolerances:
 - 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 - 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 - 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
 - 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

END OF SECTION 084313

SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes conventionally glazed aluminum curtain walls installed as stick assemblies.
- B. Related Requirements:
 - 1. Section 013573 "Delegated Design Requirements and Procedures" for definitions, submittal procedures, responsibilities, and scheduling requirements associated with delegated design assignment indicated in this Section.
 - 2. Section 079200 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes. Include 2 or more samples in each set.
- D. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
 - 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
 - 6. Cross-sectional sample of curtain wall showing thermal break construction.
- E. Delegated-Design Submittal: Refer to Section 013573 "Delegated Design Requirements and Procedures" for delegated design submittal procedures and requirements.
 - 1. Provide delegated-design submittals for glazed aluminum curtain walls.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed energy performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
- D. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- E. Energy Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
 - 1. Provide NFRC-certified glazed aluminum curtain walls with an attached label.
- F. Provide the following upon request:
 - 1. Qualification Data: For qualified Installer.
 - 2. Seismic Qualification Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 3. Welding certificates.
 - 4. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
 - a. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
 - 5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified preconstruction testing agency, for glazed aluminum curtain walls, indicating compliance with performance requirements.
 - 6. Field quality-control reports.
- G. Mockups: Build first-in-place mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Furnish all labor and materials to completely erect mockup unit of sufficient size and configuration to demonstrate the performance capabilities of the vertical wall system. Schedule mockup erection and testing sufficiently in advance of wall system fabrication to cause no delay. Do not install mockup materials as part of the wall system.
 - 2. After completion of mockup construction and prior to start of testing sequence one vision glass lite and one spandrel panels are to be removed and replaced to successfully demonstrate project reglazing procedures.
 - 3. Build mockup of typical wall area as shown on Drawings.

4. Exact configuration will be determined during wall system shop drawing review. For purposes of bidding, include costs for a vertical mockup 15feet igh by 30 feet wide with an outside corner.
5. Mockup shall have all details complete and identical to those approved on the wall system shop drawings. Mockup shall demonstrate quality of materials, finish, and workmanship, as well as compliance with performance requirements.
6. Provide schedule for mockup fabrication, erection, glazing, sealing and testing a minimum of 30 days in advance of fabrication to permit owner and Architect to coordinate monitoring and observation.
7. Field testing shall be performed on mockups in accordance with requirements in "Field Quality Control" Article.
8. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
9. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 WARRANTY

- A. Special Assembly Warranty: Standard form in which Installer agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested in accordance with ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of manufacturer's standard glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 1. Glazed aluminum curtain walls shall withstand movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.

- b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- B. Delegated Design: Engage a registered design professional, as defined in Section 013573 "Delegated Design Requirements and Procedures" to design glazed aluminum curtain walls.
1. Material properties indicated in this Section shall be considered as minimum properties.
- C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
 2. Periodic Maintenance-Equipment Loads: Minimum 250 pounds point load any place on mullions.
 3. Structural-Test Performance: Test in accordance with ASTM E 330 as follows:
 - a. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - b. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 - c. Test Durations: As required by design wind velocity, but not less than 10 econds.
 4. Deflection of Framing Members: At design wind pressure, as follows:
 - a. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
 - b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
 - c. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.
 5. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined in accordance with SEI/ASCE 7.
 - a. Component Importance Factor is 1.0.
- D. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested in accordance with ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).
- E. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested in accordance with AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).
1. Controlled Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that does not wet insulation within the wall system and that is drained to exterior.
- F. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have a total system U-factor of not more than 0.38 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100, based on center-of-glass (COG) values indicated in Section 088000.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a total system solar heat gain coefficient of no greater than 0.23 as determined in accordance with NFRC 200 based on center-of-glass (COG) values indicated in Section 088000..

3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed wall area as determined in accordance with ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).
 4. Condensation Resistance: Design the wall and its components to not develop any visible interior condensation on framing members or glazing when the exterior air dry bulb temperature is 95 deg F and the interior air dry bulb temperature is 65 deg F and with a 50 percent relative humidity.
 - a. Provide independent laboratory test reports based on AAMA 1503.1, confirming wall system performance to at least the above criteria.
 - b. If independent laboratory test reports are unavailable to verify thermal performance, provide computer analysis using THERM 5 and Windows 5 software as developed by Lawrence Berkeley National Laboratory. Include in the analysis at least all principle mullions for sill, jamb, and head conditions for vision lights and spandrel areas.
- G. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 - c. Interior Ambient-Air Temperature: 72 deg F (24 deg C)

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Arcadia, Inc.
 2. Kawneer North America; an Arconic company.
 3. Oldcastle BuildingEnvelope.
- B. Basis-of-Design: Kawneer 1600 UT

2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Front.
- B. Thermally Broken Construction:
1. Provide one of the following types of thermal break construction:
 - a. Insulbar: A glass-reinforced polyamide 6/6 nylon, with glass fibers oriented in three directions, mechanically crimped into dual dovetail-shaped slots in the aluminum extrusions.
 - b. Struct-Link or similar construction as approved: A poured and interrupted debridged polyurethane construction that periodically leaves a measured length of aluminum web to provide structural integrity, with the debridged sections continuously sealed using an elastomeric sealant.
 - c. Azon or similar construction as approved: A poured and debridged polyurethane construction with mechanically abraded surfaces that lock in the polyurethane minimizing dry shrinkage and fracturing of the polyurethane.
 - d. Pressure Bar: A continuous extruded aluminum member anchored to the window framing system with mechanical fasteners and separated from the framing by an insulating non-metallic spacer.

- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- E. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- F. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- G. Framing Sealants: Manufacturer's standard sealants with VOC content of 250g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA method 24).

2.4 MULLION EXTENSIONS, TRIM, SILLS AND CLOSURES

- A. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated, not less than adjacent curtain wall framing.
 - a. Sheet and Plate: ASTM B 209/ASTM B 209M.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221/ASTM B 221M.

2.5 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's silicone sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
 - 1. Provide gaskets that are compatible with glazing sealants and will provide for silicone adhesion.
- C. Glazing Sealants: As recommended by manufacturer.

2.6 OPERABLE UNITS

- A. Doors: Comply with Section 084113 "Aluminum-Framed Entrances and Storefronts."

2.7 SUNSHADES

- A. Aluminum airfoil sunshades attached to curtain wall framing: Refer to Section 107123 "Exterior Sun Control Devices."

2.8 ACCESSORY MATERIALS

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 2. Reinforce members as required to receive fastener threads.
 3. No exposed fastenings will be permitted in aluminum work, unless otherwise specified or indicated.
 4. In certain locations where it is impossible or highly impractical, or in locations where exposed but hidden from view, consideration will be given to exposed fastenings where such fastenings are Phillips, flat head, or countersunk machine screws, finished to match framing system.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
1. Concrete Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials or Dead-soft, 0.018-inch- thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.9 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 4. Structural Profiles: ASTM B 308/B 308M.
 5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM and prepare surfaces in accordance with applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.10 FABRICATION

- A. Form aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Physical and thermal isolation of glazing from framing members.
 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 5. Provisions for field replacement of glazing from exterior or interior.
 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

- D. Fabricate components that, when assembled, have the following characteristics:
 - 1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- E. Curtain-Wall Framing: Fabricate components for assembly using shear-block system .
- F. Factory-Assembled Frame Units:
 - 1. Rigidly secure nonmovement joints.
 - 2. Seal joints watertight unless otherwise indicated.
 - 3. Install glazing to comply with requirements in Section 088000 "Glazing."
- G. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.11 ALUMINUM FINISHES

- A. High-Performance Organic Finish, Three- Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear top coat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions .
 - 2. Color and Gloss: As indicated on Drawings.
 - a. Basis-of-Design Product: Kawneer Permafluor with clear topcoat.

PART 3 - EXECUTION

3.1 MOCKUP APPROVAL

- A. Do not proceed with erection of curtain wall work before completion and approval of mockups.

3.2 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 - 7. Seal joints watertight unless otherwise indicated.
- B. Approved mockups establish acceptable workmanship and quality standards of the Project.
- C. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- E. Install components plumb and true in alignment with established lines and grades.
- F. Install glazing as specified in Section 088000 "Glazing."

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inchwide or more, limit offset from true alignment to 1/4 inch.
 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
1. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.09 cfm/sq. ft., of fixed wall area when tested in accordance with ASTM E 783 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft..
 - a. Test Area: One bay wide, but not less than 30 feet, by one story of glazed aluminum curtain wall.
 - b. Perform a minimum of three tests in areas as directed by Architect.
 - c. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
 2. Water Penetration: Areas shall be tested in accordance with ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.
 - a. Test Area: One bay wide, but not less than 30 feet, by one story of glazed aluminum curtain wall.
 - b. Perform a minimum of three tests in areas as directed by Architect.
 - c. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.

- C. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.
- B. This Section includes the following, but is not necessarily limited to:
 - 1. Door Hardware, including electric hardware.
 - 2. Storefront and Entrance door hardware.
 - 3. Power supplies for electric hardware.
 - 4. Low-energy door operators plus sensors and actuators.
 - 5. Thresholds, gasketing and weather-stripping.
 - 6. Door silencers or mutes.
- C. Related Sections: The following sections are noted as containing requirements that relate to this Section, but may not be limited to this listing.
 - 1. Section 08 11 13 - Hollow Metal Doors And Frames
 - 2. Section 08 12 16 - Aluminum Frames
 - 3. Section 08 14 16 - Flush Wood Doors
 - 4. Section 08 41 13 - Aluminum-Framed Entrances And Storefronts
 - 5. Division 28: - Fire/Life-Safety Systems & Security Access Systems

1.2 REFERENCES (Use date of standard in effect as of Bid date.)

- A. California Building Code, CCR, Title 24.
- B. BHMA – Builders’ Hardware Manufacturers Association
- C. CCR – California Code of Regulations, Title 24, Part 2, California State Accessibility Standards.
- D. DHI – Door and Hardware Institute
- E. NFPA - National Fire Protection Association.
 - 1. NFPA 80 - Fire Doors and Other Opening Protectives
 - 2. NFPA 105 - Smoke and Draft Control Door Assemblies
- F. UL - Underwriters Laboratories.
 - 1. UL 10C - Fire Tests of Door Assemblies
 - 2. UL 305 - Panic Hardware
- G. WHI - Warnock Hersey Incorporated
- H. SDI - Steel Door Institute

1.3 SUBMITTALS & SUBSTITUTIONS

- A. General: Submit in accordance with Conditions of the Contract and Division 1 Specification sections.

- B. Submit product data (catalog cuts) including manufacturers' technical product information for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
- C. Submit six (6) copies of schedule organized vertically into "Hardware Sets" with index of doors and headings, indicating complete designations of every item required for each door or opening. Include following information:
 - 1. Include a Cover Sheet with;
 - a. Job Name, location, telephone number.
 - b. Architects name, location and telephone number.
 - c. Contractors name, location, telephone number and job number.
 - d. Suppliers name, location, telephone number and job number.
 - e. Hardware consultant's name, location and telephone number.
 - 2. Job Index information included;
 - a. Numerical door number index including; door number, hardware heading number and page number.
 - b. Complete keying information (referred to DHI hand-book "Keying Systems and Nomenclature"). Provision should be made in the schedule to provide keying information when available; if it is not available at the time the preliminary schedule is submitted.
 - c. Manufacturers' names and abbreviations for all materials.
 - d. Explanation of abbreviations, symbols, and codes used in the schedule.
 - e. Mounting locations for hardware.
 - f. Clarification statements or questions.
 - g. Catalog cuts and manufacturer's technical data and instructions.
 - 3. Vertical schedule format sample:

Heading Number 1 (Hardware group or set number – HW -1)					
			(a) 1 Single Door #1 - Exterior from Corridor 101	(b) 90°	(c) RH
			(d) 3' 0"x7' 0" x 1-3/4" x (e) 20 Minute (f) WD x HM		
(g) 1	(h)	(i) ea	(j) Hinges - (k) 5BB1HW 4.5 x 4.5 NRP (l) ½ TMS	(m) 626	(n) IVE
2	6AA	1 ea	Lockset - ND50PD x RHO x RH x 10-025 x JTMS	626	SCH

(a) - Single or pair with opening number and location. (b) - Degree of opening (c) - Hand of door(s) (d) - Door and frame dimensions and door thickness. (e) - Label requirements if any. (f) - Door by frame material. (g) - (Optional) Hardware item line #. (h) - Keyset Symbol. (i) - Quantity. (j) - Product description. (k) - Product Number. (l) - Fastenings and other pertinent information. (m) - Hardware finish codes per ANSI A156.18. (n) - Manufacture abbreviation.

- D. Make substitution requests in accordance with Division 1. Substitution requests must be made prior to bid date. Include product data and indicate benefit to the project. Furnish samples of any proposed substitution.
- E. Wiring Diagrams: Provide product data and wiring and riser diagrams for all electrical products listed in the Hardware Schedule portion of this section.
- F. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.

- G. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- H. Furnish as-built/as-installed schedule with close-out documents, including keying schedule and transcript, wiring/riser diagrams, manufacturers' installation and adjustment and maintenance information.
- I. Fire Door Assembly Testing: Submit a written record of each fire door assembly to the Owner to be made available to the Authority Having Jurisdiction (AHJ) for future building inspections.

1.4 QUALITY ASSURANCE

- A. Obtain each type of hardware (latch and lock sets, hinges, closers, exit devices, etc.) from a single manufacturer.
- B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this project and that employs an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.
 - 1. Responsible for detailing, scheduling and ordering of finish hardware.
 - 2. Stock parts for products supplied and are capable of repairing and replacing hardware items found defective within warranty periods.
- C. Hardware Installer: Company specializing in the installation of commercial door hardware with five years documented experience.
- D. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and tested by UL or Warnock Hersey for given type/size opening and degree of label. Provide proper latching hardware, door closers, approved-bearing hinges and seals whether listed in the Hardware Schedule or not.
 - 1. Where emergency exit devices are required on fire-rated doors, (with supplementary marking on doors' UL labels indicating "Fire Door to be Equipped with Fire Exit Hardware") provide UL label on exit devices indicating "Fire Exit Hardware".
- E. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Coordinate delivery of packaged hardware items to the appropriate locations (shop or field) for installation.
- B. Hardware items shall be individually packaged in manufacturers' original containers, complete with proper fasteners. Clearly mark packages on outside to indicate contents and locations in hardware schedule and in work.
- C. Provide locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, etc.
- D. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

1.6 WARRANTY

- A. Provide warranties of respective manufacturers' regular terms of sale from day of final acceptance as follows:
 - 1. Mechanical Locksets: Ten (10) years.
 - 2. Electro-mechanical locksets: Three (3) years
 - 3. Closers: Thirty (30) years –except electronic closers shall be two (2) years.
 - 4. Mechanical exit devices: Ten (10) years
 - 5. Electro-mechanical exit devices: Five (5) years
 - 6. All other hardware: Three (3) years.

1.7 MAINTENANCE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.8 PRE-INSTALLATION CONFERENCE

- A. Convene a pre-installation conference at least one week prior to beginning work of this section.
- B. Attendance: Architect, Construction Manager, Contractor, Security Contractor, Hardware Supplier, Installer, Key Owner Personnel, and Project Inspector.
- C. Agenda: Review hardware schedule, products, installation procedures and coordination required with related work. Review Owner's keying standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

<u>Item</u>	<u>Manufacturer</u>	<u>Acceptable Substitutes</u>
Hinges	Ives	Hager, Stanley, McKinney
Locks, Latches & Cylinders	Schlage	None – owner standard
Exit Devices	Von Duprin	None – owner standard
Closers	LCN	None – owner standard
Push, Pulls & Protection Plates	Ives	Trimco, BBW, DCI
Flush Bolts	Ives	Trimco, BBW, DCI
Dust Proof Strikes	Ives	Trimco, BBW, DCI
Coordinators	Ives	Trimco, BBW, DCI
Stops	Ives	Trimco, BBW, DCI
Overhead Stops	Glynn-Johnson	or Approved Equal

Thresholds	Zero	Pemko, National Guard
Seals & Bottoms	Zero	Pemko, National Guard

2.2 MATERIALS

- A. Hinges: Exterior out-swinging door butts shall be non-ferrous material and shall have stainless steel hinge pins. All doors to have non-rising pins.
1. Hinges shall be sized in accordance with the following:
 - a. Height:
 - 1) Doors up to 42" wide: 4-1/2" inches.
 - 2) Doors 42" to 48" wide: 5 inches.
 - b. Width: Sufficient to clear frame and trim when door swings 180 degrees.
 - c. Number of Hinges: Furnish 3 hinges per leaf to 7'-5" in height. Add one for each additional 2 feet in height.
 2. Furnish non-removable pins (NRP) at all exterior out-swing doors and interior key lock doors with reverse bevels.
 3. and / or stamped retainers are not acceptable.
- B. Heavy Duty Cylindrical Locks and Latches: Schlage "ND" Series as scheduled with "Rhodes" design, fastened with through-bolts and threaded chassis hubs.
1. Provide cylindrical locksets exceeding the ANSI/BHMA A156.2 Grade 1 performance standards for strength, security, and durability in the categories below:
 - a. Abusive Locked Lever Torque Test – minimum 3,100 inch-pounds without gaining access
 - b. Offset lever pull – minimum 1,600 foot pounds without gaining access
 - c. Vertical lever impact – minimum 100 impacts without gaining access
 2. Cycle life - tested to minimum 16 million cycles per ANSI/BHMA A156.2 Cycle Test with no visible lever sag or use of performance aids such as set screws or spacers
 3. UL 10C for 4'-0" x 10'-0" 3-hour fire door.
 4. Cylinders: Refer to "KEYING" article, herein.
 5. Provide solid steel anti-rotation through bolts and posts to control excessive rotation of lever.
 6. Provide lockset that allows lock function to be changed to over twenty other common functions by swapping easily accessible parts.
 7. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw capable of UL listing of 3 hours on a 4' x 10' opening. Provide proper latch throw for UL listing at pairs.
 8. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
 9. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
 10. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
 11. Provide wired electrified options as scheduled in the hardware sets.
 - a. 12 through 24 volt DC operating capability, auto-detecting
 - b. Selectable EL (fail safe)/EU (fail secure) operating mode via switch on chassis
 - c. 0.230A (230mA) maximum current draw
 - d. 0.010A (10mA) holding current
 - e. Modular / "plug in" request to exit switch
 12. Lever Trim: Solid cast levers without plastic inserts, and wrought roses on both sides.
- C. Exit devices: Von Duprin as scheduled.
1. Provide certificate by independent testing laboratory that device has completed over 1,000,000 cycles and can still meet ANSI/BHMA A156.3 - 2001 standards.

2. All internal parts shall be of cold-rolled steel with zinc dichromate coating.
 3. Mechanism case shall have an average thickness of .140".
 4. Compression spring engineering.
 5. Non-handed basic device design with center case interchangeable with all functions.
 6. All devices shall have quiet return fluid dampeners.
 7. All latchbolts shall be deadlocking with 3/4" throw and have a self-lubricating coating to reduce friction and wear.
 8. Device shall bear UL label for fire and or panic as may be required.
 9. All surface strikes shall be roller type and utilize a plate underneath to prevent movement.
 10. Lever Trim: "Breakaway" design, forged brass or bronze escutcheon with a minimum of .130" thickness, match lockset lever design.
 11. Removable Mullions: Removable with single turn of building key. Securely reinstalled without need for key.
 12. Furnish glass bead kits for vision lites where required.
 13. All Exit Devices to be sex-bolted to the doors.
 14. Panic Hardware shall comply with CBC Section 11B.404.2.7 and shall be mounted between 34" and 44" above the finished floor surface.
 - a. Provide exit devices UL certified to meet maximum 5 pound requirements according to the California Building Code section 11B-309.4, and UL listed for Panic Exterior Fire Exit Hardware.
- D. Closers: LCN as scheduled. Place closers inside building, stairs, room, etc.
1. All door closers shall be tested to ANSI/BHMA A156.4 test requirements by a BHMA certified testing laboratory. A written certification showing successful completion of a minimum of 10,000,000 cycles must be provided.
 2. All door closers shall be fully hydraulic and have full rack and pinion action with a shaft diameter of a minimum of 11/16 inch and piston diameter of 1 inch to ensure longevity and durability under all closer applications.
 3. All parallel arm closers shall incorporate one piece solid forged steel arms with bronze bushings. 1-9/16" steel stud shoulder bolts, shall be incorporated in regular arms, hold-open arms, arms with hold open and stop built in. All other closers to have forged steel main arms for strength, durability, and aesthetics for versatility of trim accommodation, high strength and long life.
 4. All parallel arm closers so detailed shall provide advanced backcheck for doors subject to severe abuse or extreme wind conditions. This advanced backcheck shall be located to begin cushioning the opening swing of the door at approximately 45 degrees. The intensity of the backcheck shall be fully adjustable by tamper resistant non-critical screw valve.
 5. Closers shall be installed to permit doors to swing 180 degrees.
 6. All closers shall utilize a stable fluid withstanding temperature range of 120 degrees F. to -30 degrees F. without requiring seasonal adjustment of closer speed to properly close the door.
 7. Provide the manufactures drop plates, brackets and spacers as required at narrow head rails and special frame conditions. NO wood plates or spacers will be allowed.
 8. Maximum effort to operate closers shall not exceed 5 lbs., such pull or push effort being applied at right angles to hinged doors. Compensating devices or automatic door operators may be utilized to meet the above standards. When fire doors are required, the maximum effort to operate the closer may be increased but shall not exceed 15 lbs. when specifically approved by fire marshal. All closers shall be adjusted to operate with the minimum amount of opening force and still close and latch the door. These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position. Per 11B-404.2.8.1, door shall take at least 5 seconds to move from an open position of 90 degrees to a position of 12 degrees from the latch jamb.
- E. Flush Bolts & Dust Proof Strikes: Automatic Flush Bolts shall be of the low operating force design. Utilize the top bolt only model for interior doors where applicable and as permitted by testing procedures.
1. Manual flush bolts only permitted on storage or mechanical openings as scheduled.

2. Provide dust proof strikes at openings using bottom bolts.
- F. Door Stops:
1. Unless otherwise noted in Hardware Sets, provide floor type with appropriate fasteners. Where wall type cannot be used, provide floor type. If neither can be used, provide overhead type.
 2. Do not install floor stops more than four (4) inches from the face of the wall or partition (CBC Section 11B-307).
 3. Overhead stops shall be made of stainless steel and non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.
- G. Protection Plates: Fabricate either kick, armor, or mop plates with four beveled edges. Provide kick plates 10" high and 1-1/2" less door width (LDW). Sizes of armor and mop plates shall be listed in the Hardware Schedule. Furnish with machine or wood screws of bronze or stainless to match other hardware.
- H. Thresholds: As Scheduled and per details.
1. Thresholds shall not exceed 1/2" in height, with a beveled surface of 1:2 maximum slope.
 2. Set thresholds in a full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements in Division 7 "Thermal and Moisture Protection".
 3. Use 1/4" fasteners, red-head flat-head sleeve anchors (SS/FHSL).
 4. Thresholds shall comply with CBC Section 11B-404.2.5.
- I. Seals: Provide silicone gasket at all rated and exterior doors.
1. Fire-rated Doors, Resilient Seals: UL10C Classified complies with NFPA 80 & NFPA 252. Coordinate with selected door manufacturers' and selected frame manufacturers' requirements.
 2. Fire-rated Doors, Intumescent Seals: Furnished by selected door manufacturer. Furnish fire-labeled opening assembly complete and in full compliance with UL10C Classified complies with NFPA 80 & NFPA 252. Where required, intumescent seals vary in requirement by door type and door manufacture -- careful coordination required.
 3. Smoke & Draft Control Doors, Provide UL10C Classified complies with NFPA 80 & NFPA 252 for use on "S" labeled Positive Pressure door assemblies.
- J. Door Shoes & Door Top Caps: Provide door shoes at all exterior wood doors and top caps at all exterior out-swing doors.
- K. Silencers: Furnish silencers for interior hollow metal frames, 3 for single doors, 2 for pairs of doors. Omit where sound or light seals occurs, or for fire-resistive-rated door assemblies.

2.3 KEYING

- A. Permanent Primus cores to be furnished and installed by owner.
- B. Furnish construction keying for doors requiring locking during construction.
- C. Furnish one Schlage cabinet lock for each cabinet door or drawer so designated on the drawings or keying schedule to match the masterkey system.
 1. Furnish CL771R for use with FSIC Schlage cylinders.

2.4 FINISHES

- A. Generally to be satin chrome US26D (626 on brass/bronze and 652 on steel) unless otherwise noted.

- B. Furnish push plates, pull plates and kick or armor plates in satin stainless steel US32D (630) unless otherwise noted.
- C. Door closers shall be powder-coated to match other hardware, unless otherwise noted.
- D. Aluminum items to be finished anodized aluminum except thresholds which can be furnished as standard mill finish.

2.5 FASTENERS

- A. Screws for strikes, face plates and similar items shall be flat head, countersunk type, provide machine screws for metal and standard wood screws for wood.
- B. Screws for butt hinges shall be flathead, countersunk, full-thread type.
- C. Fastening of closer bases or closer shoes to doors shall be by means of sex bolts and spray painted to match closer finish.
- D. Provide expansion anchors for attaching hardware items to concrete or masonry.
- E. All exposed fasteners shall have a phillips head.
- F. Finish of exposed screws to match surface finish of hardware or other adjacent work.
- G. All Exit Devices and Lock Protectors shall be fastened to the door by the means of sex bolts or through bolts.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that doors and frames are square and plumb and ready to receive work and dimensions are as instructed by the manufacturer.
- B. Beginning of installation means acceptance of existing conditions.
- C. Fire-Rated Door Assembly Inspection: Upon completion of the installation, all fire door assemblies shall be inspected to confirm proper operation of the closing device and latching device and that only the manufacturer's furnished fasteners are used for installation and that it meets all criteria of a fire door assembly per NFPA 80 (Standard for Fire Doors and Other Opening Protectives) 2013 Edition. A written record shall be maintained and transmitted to the Owner to be made available to the Authority Having Jurisdiction (AHJ). The inspection of the swinging fire doors shall be performed by a certified FDAI (Fire Door Assembly Inspector) with knowledge and understanding of the operating components of the type of door being subjected to the inspection. The record shall list each fire door assembly throughout the project and include each door number, an itemized list of hardware set components at each door opening, and each door location in the facility.

3.2 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and requirements of DHI.
- B. Use the templates provided by hardware item manufacturer.
- C. Mounting heights for hardware shall be as recommended by the Door and Hardware Institute. Operating hardware will to be located between 34" and 44" AFF.

- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- F. Set thresholds for exterior doors in full bed of butyl-rubber sealant.
- G. If hand of door is changed during construction, make necessary changes in hardware at no additional cost.
- H. Hardware Installer shall coordinate with security contractor to route cable to connect electrified locks, panic hardware and fire exit hardware to power transfers or electric hinges at the time these items are installed so as to avoid disassembly and reinstallation of hardware.
- I. Hardware Installer shall also be present with the security contractor when the power is turned on for the testing of the electronic hardware applications. Installer shall make adjustments to solenoids, latches, vertical rods and closers to insure proper and secure operation.
- J. All wiring for electro-mechanical hardware mounted on the door shall be connected through the power transfer and terminated in the interface junction box specified for in the Electrical Section.
- K. Conductors shall be minimum 18 gage stranded, multicolored. A minimum 12 in. loop of conductors shall be coiled in the interface junction box. Each conductor shall be permanently marked with its function.
- L. If a power supply is specified in the hardware sets, all conductors shall be terminated in the power supply. Make all connections required for proper operation between the power supply and the electro-mechanical hardware. Provide the proper size conductors as specified in the manufacturer's technical documentation.

3.3 ADJUST AND CLEAN

- A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.
- B. Clean adjacent surface soiled by hardware installation.
- C. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy, return to that work area and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- D. Instruct Owner's Personnel in proper adjustment and maintenance of hardware finishes, during the final adjustment of hardware.
- E. Continued Maintenance Service: Approximately six months after the completion of the project, the Contractor accompanied by the Architectural Hardware Consultant, shall return to the project and re-adjust every item of hardware to restore proper functions of doors and hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.4 HARDWARE LOCATIONS

- A. Conform to CCR, Title 24, Part 2; and ADAAG; and the drawings for access-compliant positioning requirements for the disabled.

3.5 Field quality control

- A. Hardware supplier is responsible for providing the services of an Architectural Hardware Consultant (AHC) or a proprietary product technician to inspect installation and certify that hardware and its installation have been furnished and installed in accordance with manufacturers' instructions and as specified herein.

3.6 SCHEDULE

- A. The items listed in the following schedule shall conform to the requirements of the foregoing specifications.
- B. While the hardware schedule is intended to cover all doors, and other movable parts of the building, and establish type and standard of quality, the contractor is responsible for examining the Plans and Specifications and furnishing proper hardware for all openings whether listed or not. If there are any omissions in hardware groups in regard to regular doors they shall be called to the attention of the Architect prior to bid opening for instruction; otherwise, list will be considered Complete. No extras will be allowed for omissions.
- C. The Door Schedule on the Drawings indicates which hardware set is used with each door.

Abbreviation	Name
IVE	H.B. Ives
LCN	LCN Commercial Division
SCE	Schlage Electronic Security
SCH	Schlage Lock Company
SOS	Soss Invisible Hinges
TRM	Trimco
VON	Von Duprin
WIK	Wikk Industries, Inc.
ZER	Zero International Inc

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GROUP NO. 01

1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	DOOR SWEEP	39A	A	ZER
			BALANCE OF HARDWARE EXISTING TO REMAIN		

GROUP NO. 02

1	EA	PANIC HARDWARE	CD-PA-AX-99-L-KC-06	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	26-091 ICX	626	SCH
2	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
			BALANCE OF HARDWARE EXISTING TO REMAIN		

GROUP NO. 03 - NOT USED

GROUP NO. 04

4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-99-L-KC-06	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	PER DETAIL	A	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 05 - NOT USED

GROUP NO. 06

4	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	VANDL STOREROOM LOCK	ND96TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	LOCK GUARD	LG14	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	PER DETAIL	A	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 07

3	EA	HINGE	5BB1 MATCH (E) FRAME SIZE NRP	630	IVE
1	EA	VANDL STOREROOM LOCK	ND96TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	LOCK GUARD	LG1	630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	PER DETAIL	A	ZER

GROUP NO. 08

8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	REMOVABLE MULLION	KR4954	689	VON
1	EA	ELEC PANIC HARDWARE	RX-PA-AX-99-EO	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-99-L-KC-06	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	26-091 ICX	626	SCH
2	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
2	EA	ACTUATOR, TOUCH	SEE 087113 - AUTOMATIC DOOR OPERATORS	630	LCN
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
1	SET	SEAL	WEATHER STRIPPING BY DOOR/FRAME MANUF		
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	PER DETAIL	A	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 09

8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	REMOVABLE MULLION	KR4954	689	VON
1	EA	ELEC PANIC HARDWARE	RX-PA-AX-99-EO	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-99-L-KC-06	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	26-091 ICX	626	SCH
2	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
2	EA	SURFACE CLOSER	4040XP EDA TBWMS	689	LCN
2	EA	FLOOR STOP	FS18S	BLK	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
1	SET	SEAL	WEATHER STRIPPING BY DOOR/FRAME MANUF		
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	PER DETAIL	A	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 10

6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
2	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 TW8	630	IVE
1	EA	REMOVABLE MULLION	KR4954	689	VON
1	EA	ELEC PANIC HARDWARE	RX-PA-AX-99-EO	626	VON
1	EA	ELEC PANIC HARDWARE	RX-PA-AX-99-L-M996-06-FSE	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	26-091 ICX	626	SCH
2	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
2	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	PER DETAIL	A	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 11

7	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 TW8	630	IVE
1	EA	AUTO FLUSH BOLT	FB31P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	VANDL EU STOREROOM	ND96TDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	MEETING STILE	43SP	SP	ZER
1	EA	THRESHOLD	PER DETAIL	A	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 12

8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	REMOVABLE MULLION	KR4954	689	VON
1	EA	ELEC PANIC HARDWARE	RX-PA-AX-99-EO	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-99-L-KC-06	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	26-091 ICX	626	SCH
2	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURF. AUTO OPERATOR	9553 REG2 (SEE 087113 - AUTOMATIC DOOR OPERATORS)	ANCLR	LCN
2	EA	ACTUATOR, TOUCH	SEE 087113 - AUTOMATIC DOOR OPERATORS	630	LCN
1	EA	BOLLARD	SEE 087113 - AUTOMATIC DOOR OPERATORS	630	WIK
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
1	SET	SEAL	WEATHER STRIPPING BY DOOR/FRAME MANUF		
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	PER DETAIL	A	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 13 - NOT USED

GROUP NO. 14 - NOT USED

GROUP NO. 15

4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	WALL STOP	WS401/402CVX	626	IVE
1	SET	SOUND SEALS	BY STC DOOR MFR		
1	EA	DOOR BOTTOM	BY STC DOOR MFR		
1	EA	THRESHOLD	PER DETAIL	A	ZER

GROUP NO. 16

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	GASKETING	188SBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 17

4	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 18

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ENTRANCE/OFFICE LOCK	ND50TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	ARMOR PLATE	8400/8402 34" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 19

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ENTRANCE/OFFICE LOCK	ND50TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 20

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ENTRANCE/OFFICE LOCK	ND50TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 21

4	EA	HINGE	5BB1 MATCH (E) FRAME SIZE	652	IVE
1	EA	DUTCH DOOR BOLT	054	626	IVE
1	EA	ENTRANCE/OFFICE LOCK	ND50TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	DOOR SWEEP	47A (MOUNT ON EXTERIOR SIDE OF TOP LEAF)	A	ZER

GROUP NO. 22

1	EA	KICK PLATE	8400 10" X 2" LDW B-CS BALANCE OF HARDWARE EXISTING TO REMAIN	630	IVE
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GROUP NO. 23

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ENTRANCE/OFFICE LOCK	ND50TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	SET	SOUND SEALS	BY STC DOOR MFR		
1	EA	DOOR BOTTOM	BY STC DOOR MFR		
1	EA	THRESHOLD	PER DETAIL	A	ZER

GROUP NO. 24 - NOT USED

GROUP NO. 25 - NOT USED

GROUP NO. 26

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436	626	IVE
1	SET	SOUND SEALS	BY STC DOOR MFR		
1	EA	DOOR BOTTOM	BY STC DOOR MFR		
1	EA	THRESHOLD	PER DETAIL	A	ZER

GROUP NO. 27

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 28

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 29

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 30

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 31

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 32

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ INDICATOR	ND52TD RHO IS-OCC	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS401/402CCV	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 33

4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ INDICATOR	ND52TD RHO IS-OCC	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 34

4	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ INDICATOR	ND52TD RHO IS-OCC	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS401/402CCV	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 35 – NOT USED

GROUP NO. 36

4	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	ND10S RHO	626	SCH
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS401/402CVX	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 37

3	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 5 X 4.5 TW8	652	IVE
1	EA	ELEC FIRE EXIT HARDWARE	PA-AX-98-L-F-M996-06-FS	626	VON
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	POWER SUPPLY	PS902 120/240 VAC	LGR	SCE

DOOR TO COMPLY WITH CBC 1010.2.7, EXCEPTION 3.

GROUP NO. 38 – NOT USED

GROUP NO. 39

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	PA-AX-99-L-NL-F-06	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 40

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 41

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	GASKETING	188SBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 42

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	PANIC HARDWARE	LD-PA-AX-99-L-NL-06	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
2	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

GROUP NO. 43

4	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-PA-AX-99-L-M996-06-FSE	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 44

8	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	REMOVABLE MULLION	KR4954	689	VON
2	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-99-L-KC-06	626	VON
2	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	26-091 ICX	626	SCH
3	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
2	EA	SURFACE CLOSER	4040XP EDA TBWMS	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
2	EA	FLOOR STOP	FS436	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 45

1	EA	I/C HOUSING	TYPE AS REQUIRED	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
			BALANCE OF HARDWARE BY ROLL UP DOOR MFR		

GROUP NO. 46

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP SCUSH TBWMS	689	LCN
1	EA	ARMOR PLATE	8400/8402 34" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 47

4	EA	HINGE	5BB1HW 5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP EDA TBWMS	689	LCN
1	EA	ARMOR PLATE	8400/8402 34" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS401/402CVX	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 48

4	EA	INV.HINGE	218	US26D	SOS
1	EA	DBL CYL DEADBOLT	B662T	626	SCH
2	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	ADA FLUSH PULL	1111C	630	TRM
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR BOTTOM	364AA	AA	ZER

GROUP NO. 49

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ADA STOREROOM LOCK	ND81TD RHO	626	SCH
1	EA	PRIMUS CORE	OWNER FURNISH, CONTACTOR INSTALL	626	SCH
1	EA	GASKETING	188SBK PSA	BK	ZER

END OF SECTION

SECTION 087113 - AUTOMATIC DOOR OPERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Low-energy door operators and activators for swinging doors.

1.2 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.
- B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
- C. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
- D. For automatic door terminology, see BHMA A156.19 for definitions of terms.

1.3 COORDINATION

- A. Coordinate sizes and locations of recesses in concrete floors for recessed control mats that control automatic door operators. Concrete, reinforcement, and formwork requirements are specified elsewhere.
- B. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing automatic door operators.
- C. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.
- D. Electrical System Roughing-in: Coordinate layout and installation of automatic door operators with connections to power supplies and access-control system.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic door operators.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For automatic door operators.
 - 1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
 - 2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Indicate locations of activation and safety devices.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Include plans, elevations, sections, and attachment details for guide rails.
- C. Samples: For each exposed product and for each color and texture specified, manufacturer's standard size.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of automatic door operator.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For automatic door operators, safety devices, and control systems, to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project.
- B. Certified Inspector Qualifications: Certified by AAADM.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of automatic door operators that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty or sporadic operation of automatic door operator, including controls.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide listed products by the following:
 - 1. LCN, an Allegian company (Campus Standard, no substitutions)the following:
- B. Basis-of-Design Products:
 - 1. Single Door: LCN Senior Swing Series 9540
 - 2. Double Door, Simultaneous: LCN Senior Swing Series 9550
 - 3. Double Door, Independent: LCN Senior Swing Series 9560
- C. Automatic door operators shall be surface mounted and the operator housing shall span the full-length of the opening. All wiring shall be concealed in the adjacent storefront or structural system. Exposed conduit, wire-mold, or visible electrical pathways are not acceptable.

2.2 AUTOMATIC DOOR OPERATORS, GENERAL

- A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated; and according to UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.

1. Wind Load: Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to Project design wind load as indicated on the Drawings.
- B. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation including spring closing when power is off.
- C. Hinges: See Section 087100 "Door Hardware" for hinge type for each door that door operator shall accommodate.
- D. Cover for Surface-Mounted Operators: Fabricated from 0.125-inch- thick, extruded or formed aluminum; continuous over full width of operator-controlled door opening including door jambs; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.
- E. Brackets and Reinforcements: Fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.
- F. Electrical Components, Devices, and Accessories: Concealed; Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 LOW-ENERGY DOOR OPERATORS

- A. Standard: BHMA A156.19.
- B. Performance Requirements:
 1. Opening Force if Power Fails: Not more than 15 lbf required to release latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
 2. Entrapment-Prevention Force: Not more than 15 lbf required to prevent stopped door from closing or opening.
- C. Configuration: Operator to control single swinging door.
 1. Traffic Pattern: Two way.
 2. Operator Mounting: Surface.
- D. Configuration: Operator to control pair of swinging doors.
 1. Traffic Pattern: Two way.
 2. Operator Mounting: Surface.
- E. Operation: Low-energy opening and power-assisted spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
 1. All door actuators shall be hard-wired. Wireless (battery operated) door actuators are not acceptable.
 2. All wiring for the Automatic Entrance components shall be concealed in the adjacent storefront, framing, or structural system. Exposed conduit, wire-mold, or electrical pathways are not acceptable.
 3. All automatic operators shall be surface mounted and enclosed in an extruded aluminum case extending the full width of the door frame. Access to the front of operator shall be obtained by easily removing the casing. In-ground and overhead concealed door operators are not acceptable.
 4. A keyed shut off switch keyed to the Owner's master key system shall be provided to shut off power to the outside push pads after normal hours of operation. The inside automatic door actuator must always momentarily unlock and open the automated door.

5. Electrified exit devices, locksets or strikes shall work in conjunction with door operators.
 6. Card access components shall be interfaced with door operators to allow outside actuator to open door when door is unlocked. Inside door actuator should always momentarily unlock momentarily unlock and open the automated door.
- F. Operating System: Electromechanical.
- G. Microprocessor Control Unit: Solid-state controller.
- H. Features:
1. Adjustable opening and closing speed.
 2. Adjustable opening and closing force.
 3. Adjustable backcheck.
 4. Adjustable hold-open time from zero to 30 seconds.
 5. Adjustable time delay.
 6. Adjustable acceleration.
 7. Obstruction recycle.
 8. On-off/hold-open switch to control electric power to operator; key operated.
- I. Activation Device: Push-plate switch on each side of door to activate door operator.
1. Push-Plate Switch: Momentary-contact door control switch with flat push-plate actuator with contrasting-colored, engraved message. Refer to product indicated below.
 2. Access control system shall be interfaced with automatic operator so that when door is unlocked, the outside actuator opens door. When door is locked, the outside actuator is inhibited and shall not function. The inside actuator must always temporarily unlock and open the door.

2.4 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Extrusions: ASTM B 221.
 2. Sheet: ASTM B 209.
- B. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.5 CONTROLS

- A. General: Provide controls, including activation and safety devices, according to BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate the following activation and safety devices with door operation and door operator mechanisms as indicated.
- B. Switch Bollard (Pedestal) Post:
1. Configuration: Square, 6-by-6-inch by 48-inch-high by 0.125-inch thick wall, mill aluminum with 2-coat PVDF finish to match adjacent curtain wall. Welded flat aluminum top, drainable. Rear concealed access panel.
 - a. Mounting: Surface mount with concealed mounting plate.
 - b. Preps: Two, for one accessibility vertical push-plate switch and one card reader, unless otherwise indicated. Verify configuration with Architect prior to ordering.
 - c. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Wikk Industries.
 - 2) Or equal.

- C. Card-Reader Access-Control Switch: Recessed-mounted, door-control switch with card-reader-controlled actuator; enclosed in 4-by-4-inch box where indicated.
 - 1. Face-Plate Material: Stainless steel as selected by Architect from manufacturer's full range.
 - 2. Functions: Two-way automatic, one-way exit, and off.
 - 3. Mounting:
 - a. At entry side, mount on adjacent wall where indicated.
 - 4. Integrate door activation system with access control devices specified in Division 28.
- D. Push-Plate Switch: Momentary-contact door control switch with flat push-plate actuator with contrasting-colored, engraved message.
 - 1. Configuration: Vertically-mounted, 36-inch-high, low profile, rectangular push plate with 2-by-4-inch junction box.
 - a. Mounting: Provide the following as indicated:
 - 1) Surface mounted on wall on egress side of door opening.
 - 2) Surface mounted on wall on entry side of door opening.
 - 3) Bollard mounted on entry side of door opening.
 - b. Reference Standard: Meet or exceed CBC Section 11B-404.3.5.
 - c. Basis-of-Design Product:
 - 1) Ingress'r I36-3 as manufactured by Wikk Industries, or equal by one of the following:
 - a) LCN.
 - b) Or equal.
 - 2. Push-Plate Material: Stainless steel.
 - 3. Message: International symbol of accessibility and "Push to Open;" blue.
- E. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.6 FABRICATION

- A. Factory fabricate automatic door operators to comply with indicated standards.
- B. Form aluminum shapes before finishing.
- C. Fabricate exterior components to drain condensation and water passing joints within operator enclosure to the exterior.
- D. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.

2.7 ACCESSORIES

- A. Signage: As required by cited BHMA standard for type of door and its operation.
 - 1. Application Process: Operator manufacturer's standard process.
 - 2. Provide sign materials with instructions for field application when operators are installed.

2.8 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering before shipping.
- B. Apply organic finishes to formed metal after fabrication unless otherwise indicated.

- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

- A. General: Match adjacent entrance framing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of automatic door operators.
- B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic door operator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install automatic door operators according to manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.
 - 1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
 - 2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.
- B. Controls: Install activation and safety devices according to manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel. Connect control wiring according to Division 26 Section for "Low-Voltage Electrical Power Conductors and Cables."
- C. Access-Control System: Connect operators to access-control system as specified in Division 28 Section for "Access Control."
- D. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.3 ADJUSTING

- A. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 - 1. Adjust operators on exterior doors for weathertight closure.
- B. After completing installation of automatic door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.
- C. Readjust automatic door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic door operators.

END OF SECTION

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - a. Doors.
 - b. Aluminum framing.
 - c. Interior borrowed lites and glass panels.
 - 2. Glazing sealants and accessories.
 - 3. Acoustic control products.
- B. Related Requirements:
 - 1. Section 088813 "Fire-Resistant Glazing" for glass used in fire-rated assemblies.

1.2 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Fabrication: Using primary glass in the production of single pane glass products such as coated, laminated and heat treated glass. Can be done by either the Glass Manufacturer or the Glazing Product Manufacturer.
- C. Glazing Product Manufacturer: Firm that uses fabricated glass in the production of insulating glass (multiple panes of glass).
- D. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.
- E. Large Glass Lites and Insulating Glass Units: Over 55 SF.

1.3 PERFORMANCE REQUIREMENTS

- A. Global Warming Potential: Comply with Section 018113.71 CALGreen Non-Residential Mandatory Measures for all flat glass. Do not exceed maximum allowable GWP as specified. Submit Type III EPD's to demonstrate compliance.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.
 - 3. Review glazing systems included in Project and specified in other Sections.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of glass product and glazing material specified.
- B. Shop Drawings:
 - 1. Submit shop drawings of glazing details. Draw details minimum full size (twice full size preferred) and indicate dimensions, tolerances, and materials.
 - 2. Submit Shop Drawings showing application of acoustic control product applied to existing window framing.
- C. Glass Samples:
 - 1. Each type of insulating, no less than 12 by 12 inches, including type of edge seal, spacer, and corner construction of spacer. Identify specific type of reflective and Low-e coated glass, coated surfaces, and exterior face of unit.
- D. Exposed Glazing Accessory Samples: For gaskets, sealants, and colored spacers, in 12 inch lengths. Install sealant samples between two strips of material representative in color of the adjoining framing system after sealant color selections have been made.
- E. Other Glazing Accessory Samples, as applicable:
 - 1. Corner construction of compression gasket for dry glazing with each leg approximately 6 inches long.
 - 2. Tape sealant, 6 inches long.
 - 3. Compression wedge, 6 inches long.
 - 4. Channel gasket, 6 inches long.
 - 5. Bed gasket, 6 inches long.
 - 6. Face shim or spacer.
 - 7. Setting block.
 - 8. Edge block.
 - 9. Compressible filler.
 - 10. Open cell filler.
 - 11. Acoustic control products.
- F. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Certificates:
 - 1. Upon request, submit reports indicating results of distortion and flatness monitoring and inspection for laminated and heat treated glass and for continuous on-line color measurement via spectrophotometer inspection device.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for glazing sealants, and glazing gaskets.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
 - 1. Level 1 Minimum: All installers.

- B. Provide the following upon request:
 - 1. Qualification Data: For installer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F. Do not install sealants to wet or frost covered surfaces.

1.11 WARRANTY

- A. General: During the warranty period, restore defective Work to the standard of the Contract Documents, including all labor, materials, refinishing and other costs incidental to the Work. Restore Work found to be defective as defined in the Contract Documents.
- B. Installation: Glazing systems installation shall be warranted for a period of five years against defective materials and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Products: Provide glass products as indicated, or comparable by one of the following:
 - 1. Guardian Glass; SunGuard.
 - 2. Oldcastle BuildingEnvelope.
 - 3. Pilkington North America.
 - 4. Vetrotech Saint-Gobain.
 - 5. Viracon, Inc.
 - 6. Vitro Architectural Glass (formerly PPG).
- B. Glazing Unit Fabricators: Subject to compliance with requirements, available fabricators offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Agnora.
 - 2. Cristacurva.
 - 3. JE Berkowitz, LP.
 - 4. Oldcastle BuildingEnvelope.
 - 5. Pilkington North America.
 - 6. Rochester Insulating Glass.
 - 7. Tvitec.
 - 8. Viracon, Inc.
 - 9. OnyxSolar.

- C. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- D. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.
 - 1. Design Pressures:
 - a. As indicated on Drawings.
 - b. Design Pressures: Determine design wind pressures and seismic loads applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
 - 1) Wind and Seismic Design Data: As indicated on Drawings.
 - 2. All glass and glazed assemblies below 42 inches from occupied floor surface shall be designed to withstand occupant load at all occupied locations. These loads can be imposed from the inside or outside dependent on the occupied floor surface adjacent to the glazing. Loads include but are not limited to:
 - a. 50 plf at 42 inch high from occupied floor surface.
 - b. 200 lbf point load 42 inches high from floor surface.
 - 3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces
- D. Safety Glazing:
 - 1. CPSC 16 CFR part 1201, testing requirements of ANSI Z97.1, and listed in the SGCC Certified Products Directory with appropriate SGCC certification mark or label permanently affixed.
 - 2. Furnish safety glass for glass occurring in doors and sidelights, and where indicated and further required by authorities having jurisdiction.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

1. All permanent marks and/or labels should be placed in the vicinity of the glass where the label is not obscured by the glass bite, gasket, sealant or other anchoring/glazing material. End text at least 3 mm from all site lines of the fenestration glazing to allow for readability.
- C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
 1. Minimum Glass Thickness for Exterior Lites: 6 mm.
- D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Ultraclear Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.
 1. Products Subject to compliance with requirements, provide one of the following:
 - a. AFG Industries, Inc.; Krystal Klear.
 - b. Guardian Industries Corp.; Ultrawhite.
 - c. Pilkington North America; Optiwhite.
 - d. Vitro Architectural Glass; Starphire.
- C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.
 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 2. Distortion Tolerances:
 - a. Maximum Overall Bow: 0.2% of smallest edge length.
 - b. Local Bow in any direction: Shall not exceed 1/32-inch per lineal foot.
 - c. Edge Lift: 0.008" (0.2 mm) for uncoated float glass from 6 mm to 12 mm in thickness.
 - d. Roller Wave:
 - 1) Glass Center:
 - a) Maximum 0.006 inches per 12 inches• length measured across the surface of the glass at any angle or location.
 - b) Maximum 0.003 inch from peak to valley within the main body of the sheet.
 - 2) Maximum 0.006 inch within 10.5 inches of a leading or trailing edge.
 - e. Millidiopter measurement shall be not more than plus or minus 100-mD (millidiopter) over 95-percent of the glass surface for clear or ultraclear float glass 1/4" to 3/8" thick.
 - f. Millidiopter measurement shall be not more than plus or minus 125-mD (millidiopter) over 95-percent of the glass surface all other glazing types.
 - g. Test Method: GANA "TD 04-03-26 Standard Test Method for In Plant Measurement of Roll Wave in Heat Treated Architectural Glass", or ASTM C1651.
 - h. Anisotropy (Leopard Spots and/or Iridescence): Minimize, demonstrate, and monitor the Anisotropy of all units of a given glass type to provide a reasonably uniform and homogenous strain pattern based on the following procedure. The same oven type shall be used for all units of a given glass type.
 - 1) Provide an anisotropy control process benchmarking process.
 - 2) Provide three (3) reference units for each glass type for setting allowable anisotropy. Minimum size of units is 5'-0" x 5'-0".

- 3) View the reference units on site in clear sky conditions with direct sunlight at a time of the day when the incidence of polarized light is predominant. Provide a large black fabric sheet that can be placed over the viewed panel for detailed assessment of the degree of anisotropy.
- 4) Factors that affect acceptance are the consistency of the quench marks and lack of patchy or cloudy concentrations of anisotropic effects.
- 5) The approved glass samples become the control samples, and are divided up and sent to glass fabricator, façade manufacturer, and building site.

D. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
2. For uncoated glass, comply with requirements for Condition A.
3. For coated vision glass, comply with requirements for Condition C (other coated glass).
4. Limit Kind HS surface compression to upper end of ASTM C 1048 range, 7,500 psi.
5. Distortion Tolerances:
 - a. Roller Wave: Maximum 0.003 inch from peak to valley within the main body of the sheet and maximum 0.008 inch within 10.5 inches of a leading or trailing edge.
 - b. Localized Warp: Maximum 0.03 inch over any 12 inch span, but limited to 0.31 inch.
 - c. Edge Lift: 0.008" (0.2 mm) for uncoated float glass from 6 mm to 12 mm in thickness.
 - d. Roller Wave
 - 1) Glass Center:
 - a) Maximum 0.006 inches per 12 inches• length measured across the surface of the glass at any angle or location.
 - b) Maximum 0.003 inch from peak to valley within the main body of the sheet.
 - 2) Maximum 0.008 inch within 10.5 inches of a leading or trailing edge.
 - e. Millidiopter measurement shall be not more than plus or minus 100-mD (millidiopter) over 95-percent of the glass surface for clear or ultraclear float glass 1/4" to 3/8" thick.
 - f. Millidiopter measurement shall be not more than plus or minus 125-mD (millidiopter) over 95-percent of the glass surface all other glazing types.
 - g. Test Method: GANA "TD 04-03-26 Standard Test Method for In Plant Measurement of Roll Wave in Heat Treated Architectural Glass", or ASTM C1651.
 - h. Anisotropy: Anisotropy or "Leopard Spots", a multi-color pattern known to be associated with heat-treated glass under certain polarized light conditions, shall be kept to an absolute minimum. All units of a given glass type must demonstrate after fabrication a reasonable uniform and homogenous strain pattern. The same oven type shall be used for all units of a given glass type.
 - 1) The risk of occurrence of anisotropy shall be minimized and the glass supplier shall provide an anisotropy control process benchmarking process.
 - 2) The reference units should be viewed on site in clear sky conditions with direct sunlight at a time of the day when the incidence of polarized light is predominant. The fabricator should provide a large black fabric sheet that can be placed over the viewed panel for detailed assessment of the degree of anisotropy.
 - 3) Factors that affect acceptance are the consistency of the quench marks and lack of patchy or cloudy concentrations of anisotropic effects.
 - 4) The approved glass samples become the control samples, and are divided up and sent to glass fabricator, façade manufacturer, and building site.

2.5 PRIVACY FILM

- A. Privacy Film Overlay: Translucent, dimensionally stable, cast PVC film, with pressure-sensitive, clear adhesive back for adhering to glass and releasable protective backing; opacity and pattern as indicated.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. 3M.
 - b. Llumar.
 - c. Skyline Design
2. Basis-of-Design Products: As indicated on Drawings.

2.6 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following products compatible with glazing sealant:
1. EPDM complying with ASTM C 864.
 2. Silicone complying with ASTM C 1115.
 3. Thermoplastic polyolefin rubber complying with ASTM C 1115.
 4. Compression wedge for dry glazing system: of shape and size to compress the exterior compression gasket a minimum of 25 percent, and as recommended by glazing and sealing systems manufacturer.
 5. Provide gaskets that are compatible with glazing sealants and will provide for silicone adhesion.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM, silicone, or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
1. Bed gasket for wet glazing system: continuous with pressure sensitive adhesive 1 side, designed to be compressed 25-40 percent in the opening.
 2. Compression gasket for dry glazing system: shape as required to be compressed in place a minimum of 25 percent and of one-piece construction with factory-assembled frames with injection-molded, vulcanized corners; produced oversize in opening dimension, as determined by measurements, to insure compression at corners but within limits so that compression does not create a "pucker".
 3. Channel gasket: continuous channel of shape and dimensions for application in the opening with specified glazing.
 4. Provide gaskets that are compatible with glazing sealants and will provide for silicone adhesion.

2.7 GLAZING SEALANTS

- A. General:
1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Sealant shall have a VOC content of 250 g/L or less.
 4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 5. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant:
1. Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dow Corning Corporation; 790.
 - 2) GE Construction Sealants; Momentive Performance Materials Inc.; SilPruf LM SCS2700.
 - 3) Tremco Incorporated; Spectrem 1.

- b. Applications: As recommended by glass and frame manufacturers.
- 2. Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 50, Use NT.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dow Corning Corporation; 791 or 795.
 - 2) GE Construction Sealants; Momentive Performance Materials Inc.; SilGlaze II SCS2800, SilPruf NB SCS9000, or SilPruf SCS2000.
 - 3) Tremco Incorporated; Spectrem 2 or Spectrem 3.
 - b. Applications: As recommended by glass and frame manufacturers.
- 3. Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dow Corning Corporation; 799.
 - 2) GE Construction Sealants; Momentive Performance Materials Inc.; UltraGlaze SSG4000 or UltraGlaze SSG4000AC.
 - 3) Tremco Incorporated; Tremsil 600.
 - b. Applications: As recommended by glass and frame manufacturers.

2.8 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
 - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.
- C. For openings up to 75 united inches, use unshimmed tape. For openings over 75 united inches, use pre-shimmed tape.

2.9 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
 - 1. Each block shall be properly sized for load, as wide or wider than glazing, no less than 4 inches long; profile to permit friction fit, dart insertion into metal chair, or pressure sensitive adhesive one side to fix block in glazing opening.

- D. Spacers: Elastomeric blocks or continuous extrusions of 40 to 60 Shore "A" durometer hardness to maintain glass lites in place for installation indicated.
 - 1. Profile to permit friction fit, dart insertion or pressure sensitive adhesive one side to fix shim or spacer in location.
- E. Edge Blocks: Elastomeric material of 40 to 60 Shore "A" durometer hardness to limit glass lateral movement (side walking).
 - 1. Each block shall be a minimum of 4 inches long, as wide as glazing, placed in the vertical glazing channel, and sized to allow a nominal 1/8-inch clearance between glass edge and installed block; profile to permit friction fit or pressure sensitive adhesive one side to fix block in glazing opening.
- F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Open Cell Filter: Reticulated flexible polyester urethane foam having 20 pores per inch, sized at least 1 inch larger in dimension than weephole, of cross section to provide 15 to 25 percent compression for friction fit and as manufactured by Foam Division, Scott Paper Co.; H-O Products Corp. or approved comparable product.
- H. Bond breaker : Heavy duty, 11-mil minimum thickness, colored, polyethylene or teflon, self-adhesive bond breaker of type recommended by sealant manufacturer and suitable for conditions of usage. Liquid bond breaker is not permitted.

2.10 ACOUSTIC CONTROLINFILL UNITS

- A. Product: Quantapanel; Model 602-PW.
 - 1. Application: Podcast room acoustical treatment on existing windows.
 - 2. Glass: Pyrolitic low-e glass; 6 mm, minimum.

2.11 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Edge: Omit low-e coating at IGU edge continuous for full depth of selant and spacer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
 - 1. Locate one quarter of glass width from each corner, but with block edge nearest corner no closer than 6 inches from corner, unless otherwise specified or required by glass manufacturer.
 - 2. Insulating glass used in sloped glazing shall have both panes supported by setting blocks.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

- L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.
- M. Acoustic Control Units: Install in accordance with manufacturer's instructions and approved Shop Drawings.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or backings in place and in position to control location and depth of installed sealant for required sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a smooth surface and on exterior applications provide a wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- C. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- D. Remove and replace glass that is damaged during construction period.
- E. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

- A. Glass Type IGL-1: Clear float glass.
 - 1. Glass Type: Ultra-clear float glass. Fully tempered.
 - 2. Minimum Thickness: 12.0 mm.
 - 3. Safety glazing and labeling required at hazardous glass locations as defined in CBC Section 2406.4.

3.9 INSULATING-GLASS TYPES

- A. Glass Type IGL-2: Acoustic insulated glass assembly.
 - 1. Overall Unit Thickness: 2-3/4 inch (25 mm)(16 mm).
 - 2. Thickness of Each Glass Lite: 9.0 mm
 - 3. Outdoor Lite: Ultra-clear, heat-strengthened or fully tempered float glass to meet performance requirements.
 - 4. Interspace Content: 2-inch, air.
 - 5. Indoor Lite: Ultra-clear, heat-strengthened or fully tempered float glass to meet performance requirements.
 - 6. Mounting: Refer to Drawings.
- B. Glass Type GL-1: Low-e-coated, clear insulating glass.

1. Basis-of-Design Glass: Vitro Architectural Glass Solarban 90, or equal.
2. Overall Unit Thickness: 1 inch.
3. Thickness of Each Glass Lite: 6.0 mm
4. Outdoor Lite: Clear, low-e, annealed, heat-strengthened, or fully tempered float glass to meet performance requirements.
5. Interspace Content: 1/2-inch, air.
6. Indoor Lite: Clear, annealed, heat-strengthened, or fully tempered float glass to meet performance requirements
7. Low-E Coating: #2 surface.
8. Winter U-Value (air): 0.29 with warm edge spacer.
9. Visible Light Transmittance: 51 percent
10. SHGC: 0.23
11. Safety glazing and labeling required at hazardous glass locations as defined in CBC Section 2406.4.

C. Glass Type GL-2: Low-e-coated, clear insulating spandrel glass.

1. Basis-of-Design Glass: Match GL-1
2. Overall Unit Thickness: 1 inch.
3. Thickness of Each Glass Lite: 6.0 mm
4. Outdoor Lite: Clear, low-e, annealed, heat-strengthened, or fully tempered float glass to meet performance requirements.
5. Interspace Content: 1/2-inch, air.
6. Indoor Lite: Tinted, coated, annealed, heat-strengthened, or fully tempered float glass to meet performance requirements
7. Low-E Coating: #2 surface.
8. Opaque Coating Location: Fourth surface.
9. Safety glazing and labeling required at hazardous glass locations as defined in CBC Section 2406.4.

D. Glass Type GL-3: Low-e-coated, clear insulating frosted glass.

1. Basis-of-Design Glass: Match GL-1
2. Overall Unit Thickness: 1 inch.
3. Thickness of Each Glass Lite: 6.0 mm
4. Outdoor Lite: Clear, low-e, annealed, heat-strengthened, or fully tempered float glass to meet performance requirements.
5. Interspace Content: 1/2-inch, air.
6. Indoor Lite: Clear, coated, annealed, heat-strengthened, or fully tempered float glass to meet performance requirements
7. Low-E Coating: #2 surface.
8. Ceramic Coating Color and Pattern: As selected by Architect from manufacturer's full range
9. Ceramic Coating: #4 surface.
10. Safety glazing and labeling required at hazardous glass locations as defined in CBC Section 2406.4.

E. Glass Type GL-4: Low-e-coated, clear insulating glass with privacy film overaly.

1. Basis-of-Design Glass: Match GL-1
2. Overall Unit Thickness: 1 inch (25 mm)(16 mm).
3. Thickness of Each Glass Lite: 6.0 mm
4. Outdoor Lite: Clear, low-e, annealed, heat-strengthened, or fully tempered float glass to meet performance requirements.
5. Interspace Content: 1/2-inch, air.
6. Indoor Lite: Clear, annealed, heat-strengthened, or fully tempered float glass to meet performance requirements
7. Low-E Coating: #2 surface.
8. Film Overaly Surface: #3.
9. Safety glazing and labeling required at hazardous glass locations as defined in CBC Section 2406.4.

END OF SECTION

SECTION 088813 - FIRE-RESISTANT GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire-protection-rated glazing.

1.2 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's installation instructions and standard details to ensure fire-resistance continuity.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of glass and glazing product, from manufacturer, indicating glass is intended for specific use indicated.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by Underwriters Laboratories (ULI) maintaining a current listing or certification. Label assemblies accordance with limits of manufacturer's listing.
- C. Provide the following upon request:
 - 1. Qualification Data: For installer.
 - 2. Test reports for fire-rating listing of glass.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

- A. Manufacturer's Special Warranty on Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organization below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
- B. Safety Glazing Labeling: Permanently mark glazing with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, glass thickness, and safety glazing standard with which glass complies.
- C. Each type of fire rated glass and framing shall be provided by a single-source manufacturer. Distributors of fire rated glass and framing are not to be considered as manufacturers. Materials for the project should be shipped together in the same shipment on the same truck.

2.2 FIRE-PROTECTION-RATED SAFETY GLAZING - CLEAR

- A. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 10, including the hose-stream test, and shall comply with NFPA 80.
- B. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, fire-resistance rating in minutes, and that the glazing is permitted for use in fire rated openings and has passed the hose-stream test.
- C. Ceramic Glazing, Type IGL-4: Glass made from two plies of polished clear ceramic glass.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
 - a. Technical Glass Products; FireLite Plus, Premium grade (Basis-of-Design), or Architect approved equal by one of the following:
 - 1) Interedge Technologies by AGC Flat Glass.
 - 2) SaftiFirst Fire Rated Glazing Solutions.
 - 3) Schott North America, Inc.
 - 4) Vetrotech Saint-Gobain.
 2. Note: This product does not meet radiant heat barrier test standards of ASTM E 119 or UL 263. If these test standards are required to suit condition, provide fire-resistance-rated glazing specified below with appropriate fire-rating to match wall rating condition.
- D. Properties:

1. Fire Rating: 60 minutes, unless otherwise indicated.
2. Nominal Thickness: 5/16 inch
3. Visible Light Transmission: Not less than 85 percent
4. Impact Safety Resistance: Passes
5. STC Rating: Not less than 38

E. Testing: Product shall comply with the following:

1. Fire-Protection Rating: Hose-stream tested complying with CBC Chapter 703, and the following:
 - a. Doors: NFPA 252, UL 10b and 10c
2. Impact Safety Resistance: ANSI Z97.1 and CPSC 16CFR1201(Cat. I and II).

2.3 GLAZING ACCESSORIES

A. Provide manufacturer's standard glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.

1. Glazing Tape: Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent, designed for compression of 25 percent to effect an air and vapor seal.
2. Setting Blocks: Hardwood or calcium silicate; glass width by 4 inches by 3/16 inch thick.
3. Spacers: Neoprene or other resilient blocks of 40 to 50 Shore A durometer hardness, adhesive-backed on one face only, tested for compatibility with specified glazing compound.

2.4 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with manufacturing and installation tolerances, including those for size, squareness, and offsets at corners, and for compliance with minimum required face and edge clearances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate fire side and protected side. Label or mark units as needed so that fire side and protected side are readily identifiable. Do not use materials that leave visible marks in the completed work.
- C. Examine framing components for dents, scratches, and other problems with framing or finish that may deter from finish product installation.

3.3 GLAZING, GENERAL

- A. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products in accordance with section 088000 "Glazing" as applicable.

- B. Comply with combined written instructions of manufacturers of glass, framing, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- E. Set glass lites with proper orientation so that coatings face fire side or protected side as specified.

3.4 REPAIR AND TOUCH UP

- A. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged.

3.5 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

END OF SECTION

SECTION 090561.13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fluid-applied, resin-based, membrane-forming systems that control the moisture-vapor-emission rate of high-moisture, interior concrete to prepare it for floor covering installation when required by concrete moisture and alkalinity testing specified in other Sections.
 - 1. Use of this product is only required when testing of concrete subflooring has shown evidence that allowable moisture vapor levels have been exceeded.
- B. Related Sections that may require use of this Section:
 - 1. Section 093013 "Tiling."
 - 2. Section 096516 "Resilient Sheet Flooring."
 - 3. Section 096519 "Resilient Tile Flooring."
 - 4. Section 096723 "Resinous Flooring."
 - 5. Section 096813 "Tile Carpeting."

1.2 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
 - 1. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.

1.3 DEFINITIONS

- A. MVE: Moisture vapor emission.
- B. MVER: Moisture vapor emission rate.

1.4 AREAS REQUIRING VAPOR CONTROL SYSTEM

- A. As indicated in specific Specification Sections, moisture testing performed for interior concrete slab areas receiving applied finishes determines where the vapor reduction system shall be installed. Compare test results with requirements of the flooring manufacturer.
- B. Water vapor reduction system is not required on interior concrete slabs without floor finishes.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, including concrete preparation and installation instructions.

1.6 INFORMATIONAL SUBMITTALS

- A. Certifications:
 - 1. Furnish written certification that the manufacturer has verified the compatibility between the vapor retarder provided and the flooring product scheduled to be applied, including adhesives and floor leveling materials.
 - 2. Furnish written certification of systems full conformance to all requirements of ASTM F 3010. Include independent tests confirming perm rating does not exceed 0.1 grains/sq.ft./hr in Hg-1.
 - 3. Flooring Manufacturer Acceptance of Vapor Retarder Application: Furnish a signed written statement obtained from flooring manufacturer, stating that the water vapor emission levels, after application of vapor retarders, are acceptable and suitable for their flooring application.

- B. Product Test Reports: For each MVE-control system, for tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.
 - 1. Manufacturer shall have no less than ten (10) years history in producing the same water vapor reduction systems. The moisture vapor control system must be specifically designed for concrete moisture vapor and pH control.
 - 2. Manufacturer shall provide the Owner with a standard fifteen (15) year warranty at no additional cost. Manufacturer shall not exclude ridgelines or mole lines that develop in the finished flooring material. Applicator of water vapor reduction system shall provide standard installation warranty for workmanship.
 - 3. Manufacturer shall provide documentation and Independent Laboratory test reports confirming performance and compliance with the following:
 - a. ASTM E96-05 Standard Test Method for Water Vapor Transmission of Materials in Perms (Water Method): Net Perms shall not exceed 0.1 grains/sq. ft./hr. in Hg-1. (test must be in grains/sq. ft/hr in Hg-1)
 - b. ASTM D 1308: Insensitivity to alkaline environment up to, and including, pH 14. A 14 day test is required with no degradation of sample reported.
 - c. ASTM D 7234: Minimum results 1056 PSI average
 - d. Product shall have Independent test reports of cured products showing VOC Emission compliance with USGBC LEED Version 4, performed according to California Dept. of Public Health CDPH/EHLB Standard Method V1.2.
- B. Installer Qualifications: An authorized representative who is trained and approved by MVE-control product manufacturer experienced in surface preparation and application of the material and subject to inspection by the manufacturer.
- C. Provide the following upon request:
 - 1. Qualification Data: For Installer and manufacturer.
 - 2. Preinstallation testing reports.
 - 3. Field quality-control reports.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.
 - 1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F and not more than 85 deg F at least 48 hours before use.
 - 2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F or more than 85 deg F and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

1.10 WARRANTY

- A. **Manufacturer's Special Warranty:** Manufacturer and Installer agree to repair or replace the applied concrete vapor retarder, the new floor covering or coating, including materials and labor for applied concrete vapor retarder that fails to remain adhered to the substrate or is affected by moisture or alkalinity within the specified warranty period. Manufacturer's warranty requires manufacturer's inspection and written authorization, prior to removal of existing floor covering and applied concrete vapor retarder.
 1. **Warranty Period:** 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. **MVE-Control System Capabilities:** Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
 1. **MVER:** Maximum 25 lb of water/1000 sq. ft. when tested according to ASTM F 1869.
 2. **Relative Humidity:** Maximum 100 percent when tested according to ASTM F 2170 using in situ probes.
- C. **Water-Vapor Transmission:** Through MVE-control system, maximum 0.10 perm when tested according to ASTM E 96/E 96M.
- D. **Tensile Bond Strength:** For MVE-control system, greater than 200 psi with failure in the concrete according to ASTM D 7234.

2.2 MVE-CONTROL SYSTEM

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. ARDEX Americas.
 2. KOSTER American Corporation.
 3. MAPEI Corporation.
- B. **MVE-Control System:** Fully compliant with ASTM F 3010, fluid-applied, 100 percent solids epoxy-resin, membrane-forming system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
 1. Multi-coat, water based or silicate based systems not allowed.
- C. **Substrate Primer:** Provide MVE-control system manufacturer's concrete-substrate primer if required for system indicated by substrate conditions.

2.3 ACCESSORIES

- A. Patching and Leveling Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of 3000-psi compressive strength after 28 days when tested according to ASTM C 109/C 109M.
- B. Crack-Filling Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.
- C. Cementitious Underlayment: If required to maintain manufacturer's warranty, provide MVE-control system manufacturer's hydraulic cement-based underlayment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work. Review flooring manufacturer's requirements and confirm that MVE-control products will meet or exceed the flooring manufacturer's requirements for moisture and alkalinity.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of system indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Preinstallation Testing: As required by individual Specification flooring product Sections.
- B. In addition to the above tests required by other Sections, provide the following tests for application of the MVE-control product:
 - 1. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum 100-sq. ft. area of MVE-control system to prepared concrete substrate and test according to ASTM D 7234.
 - a. Proceed with installation only where tensile bond strength is greater than 200 psi with failure in the concrete.
- C. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.
 - 1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
 - 2. Provide concrete surface profile complying with ICRI 310.2R CSP 3 by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - 3. After shot blasting, repair damaged and deteriorated concrete according to MVE-control system manufacturer's written instructions.
 - 4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
 - 5. Fill surface depressions and irregularities with patching and leveling material.
 - 6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
 - 7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
 - 8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.
- D. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.3 INSTALLATION

- A. General: Install MVE-control system according to ASTM F 3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.
 - 1. Install primers as required to comply with manufacturer's written instructions.
- B. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.
- C. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.
- D. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.
- E. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.
- F. Install cementitious underlayment over cured membrane if required to maintain manufacturer's warranty and in thickness required to maintain the warranty.

3.4 FIELD QUALITY CONTROL

- A. Installation Inspections: Engage MVE-control system manufacturer's technical representative to inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.
 - 1. Verify that surface preparation meets requirements.
 - 2. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
 - 3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.
- B. MVE-control system will be considered defective if it does not pass inspections.

3.5 CLEANING

- A. Clean application tools and equipment, and clean surrounding areas that may have been affected by the MVE-control system installation.
- B. Remove debris resulting from MVE-control system installation from Project site.

3.6 PROTECTION

- A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.
- B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION

SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes gypsum board shaft wall assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and support them on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer's written instructions.
- B. Do not install finish panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: As indicated.
- B. STC Rating: As indicated on Drawings.
- C. Gypsum Shaftliner Board:
 - 1. Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with paper faces, 1 inch thick, with double beveled long edges.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) CertainTeed Corporation; ProRoc Shaftliner.

- 2) Georgia-Pacific Building Products; ToughRock Fireguard Shaftliner.
 - 3) National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner.
 - 4) United States Gypsum Company; Sheetrock Brand Gypsum Liner Panel.
 2. Moisture- and Mold-Resistant, Fiberglass-Mat Faced: ASTM C 1658/C 1658M; manufacturer's proprietary fire-resistive liner panels with ASTM D 3273 mold-resistance score of 10 as rated according to ASTM D 3274, 1 inch thick, and with double beveled long edges.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) CertainTeed Corporation; M2Tech shaftliner Type X
 - 2) Georgia-Pacific Building Products; Dens-Glass Shaftliner.
 - 3) National Gypsum Company; Gold Bond Brand eXP Shaftliner
 - 4) United States Gypsum Company; Sheetrock Glass-Mat Liner Panel.
 3. Applications: For shaft walls and chases expected to be exposed for an extended period of time, use glass mat faced gypsum liner panels. Refer to panel manufacturer's literature for exposure limits. Replace panels exposed beyond the recommended exposure limits.
 - D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C 645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.
 1. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.
 - E. Studs: Manufacturer's standard C, H, or I profile for repetitive, corner, and end members as follows:
 1. Manufacturer: Same manufacturer providing non-structural metal framing specified in Section 092216.
 - a. Depth: As indicated.
 - b. Minimum Base-Metal Thickness: As indicated.
 - F. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
 1. Minimum Base-Metal Thickness: Matching steel studs.
 - G. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BlazeFrame Industries; Bare Slotted Track (BST/BST 2).
 - b. CEMCO; California Expanded Metal Products Co.; CST Slotted Deflection Track or SLP-TRK Slotted Deflection Track.
 - c. ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
 - d. Comprable product by selected stud manufacturer.
 - H. Elevator-Hoistway-Entrance Struts: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches, matching studs in depth, and not less than 0.033 inch thick.
 - I. Finish Panels: Gypsum board as specified in Section 092900 "Gypsum Board."
- 2.3 AUXILIARY MATERIALS**
- A. General: Provide auxiliary materials that comply with shaft wall manufacturer's written instructions.
 - B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.
 - C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

- D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
 - 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488/E 488M conducted by a qualified testing agency.
 - 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- E. Reinforcing: Galvanized-steel reinforcing strips with 0.033-inch minimum thickness of base metal (uncoated).
- F. Acoustical Sealant: Section 079219 "Acoustical Joint Sealants."
- G. Sound Attenuation Blankets: As specified in Section 98100 "Acoustical Insulation"
- H. Gypsum Board Cants:
 - 1. Gypsum Board Panels: As specified in Section 092900 "Gypsum Board," Type X, 1/2- or 5/8-inch panels.
 - 2. Adhesive: Laminating adhesive as specified in Section 092900 "Gypsum Board."
 - 3. Non-Load-Bearing Steel Framing: As specified in Section 092216 "Non-Structural Metal Framing."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer's written installation instructions.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
 - 1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
 - 2. Reinforcing: Provide where items attach directly to shaft wall assembly as indicated on Drawings; accurately position and secure behind at least one layer of face panel.

- D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons and floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated construction.
- F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Control Joints: Install control joints according to ASTM C 840, in specific locations approved by Architect and as follows, while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
 - 1. Install at changes in backup material.
 - 2. Framed Openings: Verify all locations with Architect prior to proceeding.
 - a. Doors: Install at jambs unless indicated or directed otherwise.
 - b. Glazed Openings: Install above and below jambs unless indicated or directed otherwise.
 - 3. Install at other locations indicated on Drawings.
- H. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.
- I. Gypsum Board Cants: At projections into shaft exceeding 4 inches as occurs, install gypsum board cants covering tops of projections.
 - 1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft wall framing.
 - 2. Where non-load-bearing steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft wall framing.
- J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior and exterior partitions.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product, include manufacturers height limitation tables.

1.3 QUALITY ASSURANCE

- A. Provide the following upon request:
 - 1. Product Certificates: For each type of code-compliance certification for studs and tracks.
 - 2. Evaluation Reports: For firestop tracks, post-installed anchors, power-actuated fasteners, and proprietary gypsum board ceiling suspension systems, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- C. Horizontal Deflection: For standard gypsum board wall assemblies, limit deflection to L/240 of the wall height based on horizontal loading of 5 lbf/sq. ft.. For walls supporting tile, casework, resin panels, or similar type cladding or equipment, limit deflection to L/360 of the wall height based on horizontal loading of 5 lbf/sq. ft., unless otherwise indicated by more stringent requirements on the Drawings.

2.2 FRAMING SYSTEMS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40 , hot-dip galvanized unless otherwise indicated.
- C. Studs and Tracks: ASTM C 645.
 - 1. Steel Studs and Tracks:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) CEMCO; California Expanded Metal Products Co.
 - 2) ClarkDietrich Building Systems.
 - 3) Olmar Supply
 - 4) Phillips Manufacturing Co.
 - 5) Steel Network, Inc. (The).
- b. Minimum Base-Metal Thickness: As indicated on Drawings or as required by performance requirements for horizontal deflection.
 - c. Depth: As indicated on Drawings.
- D. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Single Long-Leg Track System: ASTM C 645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 2. Double-Track System: ASTM C 645 top outer tracks, inside track with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
 3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) BlazeFrame Industries; Bare Slotted Track (BST/BST 2).
 - 2) CEMCO; California Expanded Metal Products Co.; CST Slotted Deflection Track or SLP-TRK Slotted Deflection Track.
 - 3) ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
 - 4) Equal product by selected manufacturer.
- E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BlazeFrame Industries; Intumescent Framing, Fire Stop System.
 - b. CEMCO; California Expanded Metal Products Co.; FAS Track.
 - c. ClarkDietrich Building Systems; BlazeFrame.
 - d. Fire Trak Corp; Fire Trak System attached to studs with Fire Trak Posi Klip.
 - e. Equal product by selected manufacturer.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Metal Thickness: As indicated on Drawings.
- G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
1. Depth: As indicated on Drawings.
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base-Metal Thickness: As indicated on Drawings.
 2. Depth: As indicated on Drawings.
- I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
1. Depth: As indicated on Drawings.

2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: As indicated or required by performance requirements, but not less than 18 gauge.
 2. Flange Width: 1-3/8 inches (35 mm).
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: As indicated or required by performance requirements but not less than 18 gauge.
 2. Flange Width: 1-1/2 inches (32 mm).
- C. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: As indicated or required by performance requirements, but not less than 18 gauge.
 2. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures and 1 inch (25 mm) plus twice the design gap for other applications.
- D. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - a. Minimum Base-Metal Thickness: As indicated or required by performance requirements, but not less than 18 gauge.
 - b. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures and 1 inch (25 mm) plus twice the design gap for other applications.
 2. Inner Track: Of web depth indicated, and as follows:
 - a. Minimum Base-Metal Thickness: As indicated or required by performance requirements..
 - b. Flange Width: Dimension equal to sum of outer deflection track flange width plus 1 inch (25 mm).

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Acoustical Joint Sealant: Refer to Section 079219 'Acoustical Joint Sealants.'

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Sheathing and Gypsum Board Application: Per ASTM C 754 and ASTM C 840.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
 - 2. Multilayer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. Direct Furring:
1. Attach to concrete with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Z-Shaped Furring Members:
1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, or powder-driven fasteners spaced 24 inches o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.4 INSTALLATION OF EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 1. Stud Spacing: As indicated on Drawings, but not more than 16 inches on center
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 1. Install single deep-leg deflection tracks and anchor to building structure.
 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
- E. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLING AUXILIARY MATERIALS

- A. Install auxiliary products and partition closures in accordance with manufacturer's instructions.

END OF SECTION

SECTION 092400 - CEMENT PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following plaster (stucco) materials for repairing and patching of existing plaster (stucco) surfaces and installation of any new plaster required:
 - 1. Metal lath.
 - 2. Base-coat cement plaster.
 - 3. Cement plaster finish coats.
 - 4. Accessories.

- B. Related Requirements:
 - 1. Section 072726 "Fluid-Applied Membrane Air Barriers" for weather barrier used on sheathing behind plaster.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct at Project Site at least 2 weeks prior to commencement of Work in this Section.
 - 1. Attendees: Include plaster installer, Architect, and weather barrier installer. Discuss the following:
 - a. Architect's design intent for finish and color.
 - b. Special aesthetic detail applications.
 - c. Flashing.
 - d. Review ASTM reference standards applicable to the Work of this Section, including the following:
 - 1) ASTM C 9262.
 - 2) ASTM C 1063

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

- C. Samples for Verification: For each type of finish coat and for each color and texture specified using materials and methods indicated; 12 by 12 inches, and prepared on rigid backing with lath. Match existing, unless otherwise indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Certifications:
 - 1. Certification on company letterhead indicating that the ASTM standards have been reviewed in their entirety with the Applicator and that the applicator agrees to comply with the applicable requirements therein during the installation of the cement plastering.
 - 2. Submit letter from topcoat finish manufacturer confirming that Applicator is a certified applicator in good standing with the manufacturer and qualified to perform the specified work and able to receive the required warranties.

1.5 QUALITY ASSURANCE

- A. Installer: Company specializing in performing the work of this section with minimum (5) years' documented experience on similar projects with a record of successful in-service performance.
 - 1. Applicator shall be an approved applicator by the topcoat finish manufacturer for the Work of this Section and the specified warranty.
- B. Provide the following upon request:
 - 1. Qualification statements: For installer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the Project site in manufacturer's original, unopened packages and containers bearing the manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Manufacturer's stock number and date of manufacture.
 - 3. Contents by volume, for pigment and vehicle constituents.
 - 4. Thinning instructions (if permitted).
 - 5. Application instructions.
 - 6. Color name and number.
 - 7. Handling instructions and precautions.
 - 8. VOC content.
 - 9. Safety warnings.
- B. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
- C. Store materials not in use in tightly covered containers in a well-ventilated area in an ambient temperature range of 50 deg F to 85 degrees
- D. Store leveler off of the ground in a dry area.
- E. Maintain containers in a clean condition, free of foreign materials and residue.
- F. Protect materials from freezing.
- G. Keep storage area neat and orderly.
- H. Remove oily rags and waste daily.
- I. Take necessary measures to ensure workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying materials.

1.7 FIELD CONDITIONS

- A. Comply with ASTM C926 requirements.
- B. Exterior Plasterwork:
 - 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
 - 2. Apply plaster when ambient temperature is greater than 40 deg F and allow to dry.
 - 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.

1.8 WARRANTY

- A. Installer Warranty: Installer warranty in which Installer agrees to repair or replace cement plaster assemblies or portions of assemblies that fail in materials or workmanship within the specified warranty period. Repair or replacement shall include entire assembly, including, but not limited to, accessories and flashings. Failures include, but are not limited to, delamination, non-structural cracking beyond tolerances indicated, shrinkage due to improper hydration and curing, improper placement of control joints, or water penetration through the finish.
1. Warranty Period: Five years from date of Substantial Completion.
 2. Structural causes include: transferred stresses caused by sonic resonance, seismic vibration, deflection of support members beyond specified limits, thermal shock, wind loads, settlement and/or subsidence of the building structure.

PART 2 - PRODUCTS

2.1 METAL LATH

- A. Expanded-Metal Lath: ASTM C847, cold-rolled carbon-steel sheet with ASTM A653/A653M, G60, hot-dip galvanized-zinc coating.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Alabama Metal Industries Company; a Gibraltar Industries company.
 - b. CEMCO; California Expanded Metal Products Co.
 - c. ClarkDietrich.
 2. Diamond-Mesh Lath: Flat and Self-furring, 3.4 lb/sq. yd..
- B. Wire-Fabric Lath:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ClarkDietrich Building Systems.
 - b. K-Lath; a Tree Island Steel Ltd. company.
 - c. Structa Wire Corp.
 2. Welded-Wire Lath: ASTM C933; self-furring, 2.5 lb/sq. yd. (0.8 kg/sq. m), double wire, ICC-ES ESR 2017, or equivalent.
 - a. Basis-of-Design Product: ClarkDietrich Building Systems; Twin Trac 2.5, or equal.
- C. Paper Backing: FS UU-B-790a, Type I, Grade D, Style 2 vapor-permeable paper.
1. Provide paper-backed lath over one layer of Grade D building paper when installed over rigid board insulation.
 - a. Contractor's Option: In lieu of paper-backed lath, install lath over 2-layers of Grade D building paper:

2.2 BASE-COAT CEMENT PLASTER

- A. General: Comply with ASTM C926 for applications indicated.
1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. of cementitious materials.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:

1. Portland Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
 - b. Brown Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

2.3 CEMENT PLASTER FINISH COATS

- A. Contractor's Option: Use either job-mixed finish coat or factory-blended ready mix finish coat to produce color and texture indicated.
- B. Job-Mixed Finish-Coat Mixes:
 1. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material. Add colorant according to manufacturer's instructions.
- C. Ready-Mixed Finish-Coat Plaster: Mill-mixed portland cement, aggregates, coloring agents, and proprietary ingredients.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. California Stucco Products Corp.
 - b. LaHabra Stucco Solutions; Parex USA.
 - c. Omega Products International, Inc.
 - d. Parex USA
 - e. Sto
- D. Color and Texture: As indicated on Drawings

2.4 ACCESSORIES

- A. General: Comply with ASTM C1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
 1. Provide continuous backing for securement of cement plaster accessories.
 2. Provide custom radiused accessories where substrate is radiused.
 3. Refer to Drawings for accessory shape locations. If discrepancies exist, notify Architect in advance of ordering materials.
- B. Metal Accessories:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Alabama Metal Industries Company; a Gibraltar Industries company.
 - b. Brand X Metals, Inc.
 - c. CEMCO; California Expanded Metal Products Co.
 - d. ClarkDietrich.
 2. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A653/A653M, G60 zinc coating.
 3. Soffit Drip Edge: Fabricated with 4 inch vertical flange without weep holes from hot-dip galvanized-steel sheet, ASTM A653/A653M, G60 (Z180) zinc coating.
 4. Cornerbeads: Fabricated from zinc zinc-coated (galvanized) steel or anodized aluminum.
 - a. Smallnose cornerbead with expanded flanges; use unless otherwise indicated.

5. External- (Outside-) Corner Reinforcement: Fabricated from metal lath with ASTM A653/A653M, G60 (Z180), hot-dip galvanized-zinc coating, where cornerbeads are not used.
6. Casing Beads: Fabricated from zinc zinc-coated (galvanized) steel or anodized aluminum; square-edged style; with expanded flanges.
7. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint. Usae at floor lines and where otherwise indicated.
 - a. Vertical: One-piece double "J" type; with perforated flanges and removable protective tape on plaster face of control joint.
 - b. Horizontal: One-piece double "V" type; with perforated flanges and removable protective tape on plaster face of control joint.
8. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges. Prime and paint reveals in color to be selected by Architect in accordance with Division 09 "Exterior Painting."
9. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch wide; with perforated flanges.
- 10.

2.5 PLASTER MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II.
 1. Color for Job-Mixed Finish Coats: In color required to produce specified color.
- B. Lime: ASTM C206, Type S; or ASTM C207, Type S.
- C. Sand Aggregate: ASTM C897.
 1. Color for Job-Mixed Finish Coats: In color required to produce specified color.
- D. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color as indicated.

2.6 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in cement plaster.
- C. Bonding Compound: ASTM C932.
- D. Fasteners for Attaching Metal Lath to Substrates: ASTM C1063.
- E. Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter unless otherwise indicated.
- F. Acrylic Polymer Admixture: 100 percent acrylic polymer admixture for brown coat.
- G. Self-Adhering Stainless Steel Flexible Flashing:
 1. Subject to compliance with requirements, provide the following:
 - a. York Manufacturing Inc.; York 304 SA.
 2. Characteristics:

- a. Type: Stainless steel with one stainless steel face (facing outwards) with a butyl block co-polymer adhesive (inward facing).
- b. Stainless Steel: Type 304, ASTM A240. Domestically sourced per DF ARS 252.225-7008 and/or DF ARS 252.225-7009.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Surfaces to receive finish system must be thoroughly dry before materials are applied.
- C. Notify the Architect in writing of anticipated problems using products specified over substrates.
- D. Start of application within a particular area will be construed as the acceptance of surface conditions.
- E. Deflection Tolerance: Walls to received plaster shall have a deflection tolerance of no greater than L/360.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated.
 1. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and product application.
 2. After completing operations in each area, reinstall items removed, using workers skilled in trades involved.
- C. Cleaning: Before applying materials or other surface treatments, clean substrates of substances that could impair bond of coating systems.
 1. Remove oil and grease before cleaning.
 2. Schedule cleaning and materials application so dust and other contaminants will not fall on wet, newly applied surfaces.

3.3 MIXING

- A. Mix materials in strict conformance with the manufacturer's written requirements and recommendations. Mix materials for a minimum of 4 minutes. If manufacturer's published mixing times conflict with this requirement, bring the discrepancy to the attention of the waterproofing consultant prior to mixing and application.
- B. Mix using measuring devices of known volume with successive batches proportioned alike.
- C. Add polymer admixture to brown coat according to admixture manufacturer's recommended mix rates.

3.4 INSTALLATION, GENERAL

- A. Install manufactured components in accordance with manufacturer's written instructions and recommendations
- B. Continuously reinforce internal angles.
- C. Frame both sides of expansion joints independently unless otherwise indicated, do not bridge joints with furring and lathing or accessories
- D. Fixture Support Framing: Install supplementary framing, blocking and bracing where work is indicated to support fixtures, equipment, services and similar work requiring attachment and support
- E. Coordinate installation of anchors, blocking, electrical and mechanical work which is to be placed in or behind framing; allow such items to be installed after framing is complete.
- F. Install self-adhering flashing at inside corners, outside corners, behind stucco accessories, at penetrations, and to strip in drip/weep screeds unless otherwise shown or noted.

3.5 INSTALLATION OF METAL LATH

- A. Metal Lath: Install according to ASTM C 1063.
 - 1. Partition Framing and Furring over Rigid Board Insulation: Diamond-mesh attached directly to metal studs or thermal spacer cladding attachment brackets in locations indicated.
 - a. Diamond-Mesh: Install paper-backed self-furring-diamond-mesh lath over one-layer Grade D building paper. Attach lath to metal z-furring.
 - 1) In lieu of paper-backed lath, install metal lath over 2-layers of Grade D building paper.
- B. Install metal furring and lathing so that the finished plaster surfaces are true to line, level, plumb, square, or curved as required to receive the specified plaster thickness.
 - 1. Tolerance: 1/4 inch in 10 ft.
- C. Place 6" wide x 12" long strips of metal lath diagonally at corners of openings; secure rigidly in place
- D. Place 6" wide strips of metal lath at junctions of dissimilar materials; place parallel with dissimilar materials; secure rigidly in place.
- E. Pattern: 16 inches horizontally and 6 inches vertically (similar to a framed wall).
- F. Fasteners shall project through metal studs not less than 3/8 inch or three full threads, whichever is greater, unless more stringent requirements are indicated in ASTM C 1063.
- G. Fasteners shall engage not less than three strands of lath.
- H. Apply sealant over fasteners at open framing.
- I. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition or wall abuts overhead structure, sufficiently isolate from structural movement to prevent transfer of loading from building structure.

3.6 INSTALLATION OF ACCESSORIES

- A. Install according to ASTM C1063 and at locations indicated on Drawings.

- B. Reinforcement for External (Outside) Corners:
 - 1. Install cornerbead at interior locations.
 - 2. Install lath-type, external-corner reinforcement at exterior locations.
- C. Control Joints: Locate as approved by Architect for visual effect and as follows:
 - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 144 sq. ft..
 - b. Horizontal and Other Nonvertical Surfaces: 100 sq. ft..
 - 2. At distances between control joints of not greater than 18 feet o.c.
 - 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 - 4. Where control joints occur in surface of construction directly behind plaster.
 - 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.
- D. Transition Membranes and Opening Flashing: Install in proper sequence to maintain drainage by lapping from above. Where feathering into existing weather barriers or building paper, lap weather barrier over flashing at head of opening, and lap window flashing over existing weather barriers at sill.
 - 1. Install self-adhering stainless steel flashing in openings according to manufacturer's instructions and recommended configurations.

3.7 CUTTING AND PATCHING EXISTING

- A. Carefully cut existing plaster to allow the installation of work.
 - 1. Score the existing surface with a diamond blade and carefully chisel existing cement plaster away from existing metal lath.
 - 2. Grind the existing finish coat 4 inches beyond removed cement plaster.
 - 3. Under-cut existing plaster edge to create a dovetail connection with the repair plaster.
 - 4. Protect existing metal lath and paper backing to the greatest extent possible.
 - 5. Protect keys of surround plaster.
- B. Patch and repair plaster as necessary to accommodate the other work and to match existing adjacent finishes to the greatest extent possible.
 - 1. Apply bonding agent at joint between existing stucco and repair.

3.8 APPLICATION OF BASE-COAT CEMENT PLASTER

- A. General: Comply with ASTM C926.
 - 1. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces when measured by a 10-foot straightedge placed on surface.
 - 2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
 - 3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
- B. Walls; Base-Coat Mixes for Use over Metal Lath: For scratch and brown coats, for three-coat plasterwork with 7/8-inch total thickness, as follows:
 - 1. Portland cement mixes.
- C. Ceilings; Base-Coat Mixes for Use over Metal Lath: For scratch and brown coats, for three-coat plasterwork with 3/4-inch total thickness, as follows:

1. Portland cement mixes.

D. Installation of Base Coats:

1. Scratch Coat: apply stucco with sufficient pressure to key into and embed the metal lath. Apply sufficient material, 3/8 or 1/2-inch, to cover the metal lath and to permit scoring the surface. Score the stucco upon completion of each panel in preparation for a second coat. Score horizontally.
2. Brown Coat: as soon as the first coat is firm enough to receive the second coat without damage, apply the second coat. Alternatively, moist cure the first coat up to 48 hours and dampen the scratched surface with water immediately before applying the second coat. Apply the second coat with sufficient pressure to ensure intimate contact with the first coat and as needed to bring the stucco to a uniform thickness that matches the grounds of the accessories. Use a rod or straight edge to bring the surface to a true, even plane. Fill depressions in plane with stucco. Final thickness of stucco shall be uniform throughout the wall area and shall be either 3/4-inch or 7/8-inch as required by design, and shall not exceed 7/8-inch.

- E. After the stucco has become slightly firm float the surface lightly with a darby or wood float to densify the surface and to provide a smooth, even surface. The proper time to float is when the wood float no longer sticks to the surface of the stucco.

- F. Moist cure after the stucco has set by lightly fogging for at least 48 hours. Fog as frequently as required during the 48-hour period to prevent loss of moisture from the stucco. Avoid eroding the stucco surface with excess moisture. If relative humidity exceeds 75% the frequency of moist curing can be diminished.

- G. Allow base coat(s) to dry prior to applying primer if primer is required for application of finish coat.

3.9 APPLICATION OF PLASTER FINISH COATS

- A. Plaster Finish Coats: Apply to provide finish in texture indicated. Confirm color and texture using Sample submittals prior to installation on building.

1. Texture:
 - a. New Construction: As indicated on Drawings.
 - b. Existing Construction: As indicated on Drawings to match existing, unless otherwise indicated.

- B. Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.

3.10 FIELD QUALITY CONTROL

- A. The District reserves the right to invoke the following test procedure at any time and as often as the District deems necessary during the period when coating operations are being conducted:

1. The District may engage the services of a qualified independent testing and inspecting agency to sample materials used. Samples of material delivered to the Project will be taken, identified, sealed, and certified in presence of the Contractor.
2. The testing and inspecting agency will perform appropriate tests, as required by the District.
3. If results show materials do not comply with requirements, the Contractor may be directed to stop work, remove noncomplying materials, pay for testing, recoat surfaces coated with rejected materials, or remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two materials are not compatible.

- B. pH Testing: Between each coat of plaster and prior to application of paint finish.

1. Testing performed by Contractor; observed by District's QA/QC representative.
 - a. pH equal to or less than 13 is acceptable.

3.11 REPAIR

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.
- B. Where indicated to repair or patch existing plaster, match color and texture of existing.
- C. Crack Tolerance: Cracks that appear within the first 30 days after installation and are larger than 1/16 inch (the thickness of a penny) shall be filled or repaired with a slurry of the same color coat material. Cracks that are patched and re-appear could indicate a structural or substrate movement problem and should be evaluated for cause. Patch cracks more than 1/16 inch thick if visible from more than 10 feet away or if a source of leaking. Fog coat or paint the entire panel if hairline cracks less than 1/16 inch thick are visible from more than 10 feet away.
 - 1. Refer to Stucco Manufacturers Association (SMA) "Stucco Crack Policy" and the Wall & Ceiling Conference (WCC) Technical Bulletin 6.002 for additional information.

3.12 CLEANING

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from the Project site.
- B. After completing coating work, clean glass and spattered surfaces. Remove spattered coatings by washing, scraping, or other methods, being careful not to scratch or damage adjacent finished surfaces.
- C. Remove temporary protection and enclosure of other work after plastering is complete.
- D. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered.
- E. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

3.13 PROTECTION

- A. Protect work of other trades from damage whether being coated or not. Correct damage by cleaning, repairing, replacing, and recoating as approved by the Architect. Leave in an undamaged condition.
- B. Provide "Wet Paint" signs to protect newly applied materials.
- C. Remove temporary protective wrappings provided by others to protect their work after completing coating operations.
 - 1. After construction activities of other trades are complete, touch up and restore damaged or defaced surfaces.
- D. Provide protection of installed materials from water infiltration into or behind them.
- E. Provide protection of installed cement plaster from dust, dirt, precipitation, and freezing.
- F. Provide protection of installed primer and finish from dust, dirt, precipitation, freezing and continuous high humidity until fully dry.
- G. Protect and clean landscaping free of cement plaster debris.

END OF SECTION 092400

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.
 - 3. Joint compounds.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Building Products.
 - c. National Gypsum Company.
 - d. United States Gypsum Company.
 2. Thickness: 5/8 inch (15.9 mm).
- B. Flexible Gypsum Board: ASTM C1396/C1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Certainteed; SAINT-GOBAIN.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. PABCO Gypsum.
 - e. USG Corporation.
 2. Thickness: 1/4 inch (6.4 mm).
 3. Long Edges: Tapered.
- C. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Certainteed; SAINT-GOBAIN.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. PABCO Gypsum.
 - e. USG Corporation.
 2. Core: 5/8 inch (15.9 mm), Type X.
 3. Long Edges: Tapered.
 4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 SPECIALTY GYPSUM BOARD

- A. Glass-Mat Interior Gypsum Board: ASTM C1658/C1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Georgia-Pacific Gypsum LLC.
 - b. National Gypsum Company.
 - c. PABCO Gypsum.
 - d. USG Corporation.
 2. Core: 5/8 inch (15.9 mm), Type X.

3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Certainteed; SAINT-GOBAIN.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - d. USG Corporation.
 2. Core: 5/8 inch (15.9 mm), Type X.
 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- B. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Certainteed; SAINT-GOBAIN.
 - b. National Gypsum Company.
 - c. USG Corporation.
 2. Thickness: 5/8 inch (15.9 mm).
 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet Galvanized or aluminum-coated steel sheet or rolled zinc Plastic Paper-faced galvanized-steel sheet.
 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - e. Expansion (control) joint.
- B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and drywall trim channels of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, cross-T/main beam interface, and alignment, hanging, adjustment and attachment clips, and other connector and holddown clips as needed, complying with seismic design requirements.
1. Basis-of-Design Products: Armstrong Axiom.
 - a. Axiom One-Piece Trim for Drywall, 4 inches; No. AX1PC4STR.
 2. Baked-Polyester: Trim manufacturer's standard. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - a. Colors and Patterns: As selected by Architect from manufacturer's available colors and patterns.
 3. Warranty Period:
 - a. Perimeter Trim Components: Ten (10) years from date of substantial completion.

2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
 - 3. Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.
- D. Joint Compound for Backing Panels:
 - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
 - 2. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.8 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
- D. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- E. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."
- F. Firestop Putty Pads for Electrical Boxes: As specified in Section 078413 "Penetration Firestopping."
- G. Acoustic Putty Pads for Electrical Boxes: As specified in Section 079219 "Acoustical Joint Sealants."
- H. Sound-Attenuation Insulation: As specified in Section 098100 "Acoustical Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Gypsum board shall be held back from intersecting surfaces at the perimeter of edges of sound-resistance-rated partitions a minimum 1/4-inch. Finish over sealed joints with tape and compound, and sand and finish to match adjacent surfaces. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
1. Type X: Typical interior surfaces.
 2. Flexible Type: As indicated on Drawings at cove lights. Apply in double layer at curved assemblies.
 3. Mold-Resistant Type: As indicated on Drawings and where gypsum board must be installed prior to building being enclosed and conditioned.
 4. Glass-Mat Interior Type: As option where gypsum board must be installed prior to building being enclosed and conditioned.
- B. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
 4. Fastening Methods: Fasten base layer with screws; fasten face layers with adhesive and supplementary fasteners.
- D. Curved Surfaces:
1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- (300-mm-) long straight sections at ends of curves and tangent to them.
 2. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.

3.4 INSTALLATION OF BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at non-wet locations indicated to receive tile or other indicated finish materials. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
- B. Cementitious Backer Units: ANSI A108.11, at wet area locations indicated to receive tile or other indicated finish materials.

- C. Where backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners unless otherwise indicated.
 - 2. LC-Bead: Use at exposed panel edges.
 - 3. L-Bead: Use where indicated.
 - 4. U-Bead: Use at exposed panel edges.
- D. Firestop Putty Pads: Install at electrical boxes located in fire-rated partitions. Install in accordance with pad manufacturer's instructions.
- E. Acoustic Putty Pads: Install at electrical boxes located in acoustic-rated partitions. Install in accordance with pad manufacturer's instructions.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 3: Panels that are substrate for heavy grade wall coverings.
 - 4. Level 4: Level 4: At typical panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
 - 5. Level 5: Below and inside cove lighting or wall wash lighting, surfaces to receive wall covering or wall covering graphic signage, or as indicated on drawings.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Glass-Mat Interior Gypsum Board: Finish according to manufacturer's written instructions to suit applications. Exposed surfaces shall have level 5 finish.
- F. Glass-Mat Faced Backer Panels: Finish according to manufacturer's written instructions.
- G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 093013 - TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wall tile.
 - 2. Setting materials.
 - 3. Waterproofing, crack isolation and uncoupling membranes.
 - 4. Grout materials.
 - 5. Metal edge strips.

- B. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for sealing of movement joints in tile surfaces.
 - 2. Section 092900 "Gypsum Board" for tile backing panels.

1.2 DEFINITIONS

- A. General: Definitions in ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Large Format Tile: Tile with at least one edge 15 inches or longer.
- D. Module Size: Actual tile size plus joint width indicated.
- E. Wet Area: The term "wet area" refers to shower rooms and other areas with similar usages. It does not refer to toilet rooms and other similar areas where water on the floor is seldom encountered.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations, plans, and elevations, of each type of tile and tile pattern. Show widths, details, and locations of movement joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For accessories involving color selection or shade variation.
- D. Samples for Verification:
 - 1. Three full-size units of each type and composition of tile and for each color and finish required showing variations in color, texture and pattern.
 - 2. Metal edge strips; 6-inch lengths.

1.5 QUALITY ASSURANCE

- A. Minimizing Tile Lippage: Tolerance for lippage on installed tiles shall meet or exceed the requirements of ANSI A108.2:

1. Tile Joint of 1/4 inch or less: 1/32 inch allowable lippage.
 - a. It is recommended, though not required, that tiles greater than 12 inches in either edge dimension should be installed using a leveling system designed to control lippage and other related installation control activities in accordance with ANSI A108.03; Section 4.3.7.

B. Provide the following upon request:

1. Qualification Data: For Installer.
2. Product Certificates: For each type of product, including product use classification.
3. Product Test Reports: For tile-setting and -grouting products.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Tile: Obtain tile of each type and color or finish from single source or producer.
 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
 2. Endeavor to provide manufacturer's full system warranty as much as possible.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 1. Obtain setting and grouting materials, except for unmodified portland cement and aggregate, from single manufacturer.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 1. Provide tile complying with Standard Grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.3 TILE PRODUCTS

- A. General: Refer to Drawings for Basis-of-Design tile type, manufacturer, and size. Comparable products by one of the listed manufacturers may be submitted for approval by Architect. Comparable products shall be equivalent in size, color, pattern, thickness and type.
- B. Acceptable Manufacturers: Manufacturer's that may provide products comparable to the basis-of-design products listed on the Drawings, include the following:
 - 1. Crossville, Inc.
 - 2. DalTile Group, Inc.
 - 3. Walker Zanger

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 - 1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
- B. Solid Surface Material Thresholds: Homogeneous-filled plastic resin complying with ICPA SS-1 and Section 123661.16.
 - 1. Type: Standard Type.
 - a. Basis-of-Design Product: Du Pont; Corian or equal.
 - 2. Width: As indicated. Center width under door at door openings.
 - 3. Length: As indicated full length or as needed to transition full width of door opening.
 - 4. Colors and Patterns: As selected by Architect from solid surface material manufacturer's available colors and patterns.

2.5 TILE BACKING PANELS

- A. Specified in Section 092900 "Gypsum Board."

2.6 LIQUID WATERPROOF / CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Manufacturer's: Subject to compliance with requirements, provide products from one of the following manufacturer's, or provide listed product for full system warranty:
 - 1. Ardex Americas
 - 2. Custom Building Products

3. Laticrete International, Inc.
4. MAPEI Corporation.

C. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or Architect approved equal by listed manufacturer:
 - a. Laticrete International, Inc.; Laticrete Hydro Ban.

2.7 CRACK ISOLATION SHEET MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Manufacturer's: Subject to compliance with requirements, provide products from one of the following manufacturer's, or provide listed product for full system warranty:

1. Ardex Americas
2. Custom Building Products
3. Laticrete International, Inc.
4. MAPEI Corporation.

C. Crack Isolation Membrane: High-performance, pliable, polymer-modified self-adhesive crack isolation membrane.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or Architect approved equal by listed manufacturer:
 - a. Product: Laticrete International, Inc.; Fracture Ban

2.8 UNCOUPLING MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Uncoupling Membrane: ASTM C 627 and ANSI A118.12.

1. Manufacturer's: Subject to compliance with requirements, provide products from one of the following manufacturer's:
 - a. Custom Building Products
 - b. Laticrete International, Inc.
 - c. Mapei Corporation
 - d. Schluter Systems, LLP.
2. Basis-of-Design Product: Schluter Ditra

2.9 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.

1. Cleavage Membrane: Asphalt felt, ASTM D 226/D 226M, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.

B. Manufacturer's: Subject to compliance with requirements, provide products from one of the following manufacturer's, or provide listed product for full system warranty:

1. ARDEX Americas.
2. Custom Building Products.

3. Laticrete International, Inc.
4. MAPEI Corporation.

C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Floors:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide the following or Architect approved equal by listed manufacturer:
 - 1) Wall Product: Laticrete International Inc.; Laticrete 254 Platinum, or 254R for rapid-setting..
2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.4.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide the following or Architect approved equal by listed manufacturer:
 - 1) Wall Product: Laticrete International Inc.; Laticrete 255 MultiMax.

2.10 GROUT MATERIALS

A. Manufacturer's: Subject to compliance with requirements, provide products from one of the following manufacturer's, or provide listed product for full system warranty:

1. ARDEX Americas.
2. Custom Building Products.
3. Laticrete International, Inc.
4. MAPEI Corporation.

B. High-Performance Tile Grout: ANSI A118.7.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or Architect approved equal by listed manufacturer:
 - a. Laticrete International Inc.; Permacolor grout.

C. Water-Cleanable Epoxy Grout: ANSI A118.3.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the following or Architect approved equal by listed manufacturer:
 - a. Laticrete International, Inc.; Laticrete SpectraLOCK Pro Premium.

D. Reference Finish Schedule for grout color. Confirm joint thickness with Architect.

2.11 METAL EDGE STRIPS

A. Metal Edge Strips: Tile edge protection and transitions strips of width shown, of height required to protect exposed edges of tile, and maximum available lengths to minimize running joints; satin anodized aluminum.

1. Basis of Design Manufacturers: Subject to compliance with requirements, provide basis-of-design shapes indicated as manufactured by the following:
 - a. Schluter Systems, LP, or comparable by one of the following:
 - 1) Blanke Corporation.
 - 2) Progress Profiles.
2. Basis-of-Design Products: As occurs. Sizes as indicated on Drawings.
 - a. Tile wainscot top and exposed Edges: Schluter Rondec-DB.
 - b. Other conditions as required or indicated as directed by Architect.

2.12 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
 - 1. Basis-of-Design Products: Subject to compliance with requirements, provide the following, or Architect approved equal:
 - a. Ardex Americas; K15, V-1200, or Feather Finish, or approved equal, as required to suit conditions.
- B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D 4397, 4.0 mils thick, tape seams.
- C. Mesh Tape: 2-inch wide self-adhesive fiberglass mesh tape as instructed by backer manufacturer.
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.13 ELASTOMERIC SEALANTS

- A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the applicable requirements in Section 079200 "Joint Sealants."
 - 1. Sealants shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.

2.14 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings that are incompatible with tile-setting materials.
- B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- C. Substrate Flatness:
 - 1. For tile shorter than 15 inches, confirm that structure or substrate is limited to variation of 1/4 inch in 10 ft. from the required plane, and no more than 1/16 inch in 12 inches when measured from tile surface high points.
 - 2. For large format tile, tile with at least one edge 15 inches or longer, confirm that structure or substrate is limited to 1/8 inch in 10 ft. from the required plane, and no more than 1/16 inch in 24 inches when measured from tile surface high points.

3.3 TILE BACKING PANEL INSTALLATION

- A. Install backer units and treat joints according to Section 092900 "Gypsum Board."

3.4 INSTALLATION OF CERAMIC TILE SYSTEM

- A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.
- B. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
 - 1. Add materials, water, and additives in accurate proportions.
 - 2. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.
- C. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
 - b. Tile floors consisting of tiles 8 by 8 inches or larger.
 - c. Tile floors consisting of rib-backed tiles.
- D. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- F. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- G. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- H. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - 3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- I. Joint Widths: Unless otherwise indicated, match walls and floors, and install tile with joint widths as directed by Architect.
- J. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- K. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
 - 2. Apply sealant and back-up to joints.
 - 3. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.
- L. Solid Surface Thresholds: Install thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
 - 1. Do not extend cleavage membrane, waterproofing, or crack isolation membrane under thresholds set in modified dry-set mortar. Fill joints between such thresholds and adjoining tile set on waterproofing or crack isolation membrane with elastomeric sealant.
- M. Metal Edge Strips: Install at exposed edges, and where edge of tile flooring meets carpet or resilient flooring that finishes flush with or below top of tile and no threshold is indicated.

3.5 FLUID-APPLIED WATERPROOFING / CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- B. Allow waterproofing to cure and verify by testing for watertightness before installing tile or setting materials over it.

3.6 CRACK ISOLATION SHEET MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

- C. When allowed by waterproof membrane manufacturer, crack isolation membrane may be omitted where fluid-applied waterproofing is indicated.

3.7 INSTALLATION - FLOORS - THIN-SET METHODS

- A. General: Refer to TCNA design methods and tile installation Schedule at the end of this Section to suit condition. Not all conditions may be listed, and in some cases methods have been modified and combined to meet specific project conditions

3.8 INSTALLATION - FLOORS - MORTAR BED METHODS

- A. General: Refer to TCNA design methods and tile installation Schedule at the end of this Section to suit condition. Not all conditions may be listed, and in some cases methods have been modified and combined to meet specific project conditions

3.9 INSTALLATION - WALL TILE

- A. General: Refer to TCNA design methods and tile installation Schedule at the end of this Section to suit condition. Not all conditions may be listed, and in some cases methods have been modified and combined to meet specific project conditions
- B. Over cementitious backer board on vapor retarder membrane on metal studs, install with modified non-sagging cement mortar adhesive in accordance with TCNA Method W244 with high-performance grout.
- C. Over coated glass mat backer board on metal studs, install with modified non-sagging cement mortar adhesive in accordance with TCNA Method W248 with high-performance grout.

3.10 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
 - 1. Replace tiles that do not meet lippage requirements.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile in accordance with tile and grout manufacturer's written instructions. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.11 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.12 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. General: Utilize the following as applicable to conditions indicated on Drawings. Consult with Architect for questions or possible conflicts.
1. Grout Type: Use water-cleanable epoxy grout, unless otherwise indicated.
- B. Interior Floor Installations, Concrete Subfloor:
1. Tile Installation: TCNA F114 and ANSI A108.1C; cement mortar bed on cleavage membrane, epoxy grout, on- or above- grade.
 - a. Tile Type: Non-large format floor tile as indicated.
 - b. Setting: Tile set with dry-set bond coat on unreinforced mortar bed over cleavage membrane, with total thickness to allow tile in recessed concrete slab set flush with adjacent flooring as indicated.
 - c. Grout: Water-cleanable epoxy grout.
 2. Tile Installation: TCNA F114 (Modified) and ANSI A108.1C; Bond coat on uncoupling membrane on unbonded cement mortar bed, epoxy grout, on- or above- grade.
 - a. Tile Type: Any large format tile type.
 - b. Setting: Tile set with dry-set bond coat on uncoupling membrane set with dry-set bond coat on unreinforced mortar bed over cleavage membrane, with total thickness to allow tile in recessed concrete slab set flush with adjacent flooring as indicated.
 - 1) Bond Coat: Thinset mortar compatible with uncoupling membrane, either modified or unmodified as instructed by uncoupling membrane manufacturer.
 - c. Grout: Water-cleanable epoxy grout.
 3. Tile Installation: TCNA F115; thinset mortar; epoxy grout, on- ground.
 - a. Tile Type: Non-large format floor tile as indicated.
 - b. Thinset Mortar: Modified dry-set mortar.
 - c. Grout: Water-cleanable epoxy grout.
 4. Tile Installation: TCNA F115A; thinset mortar; epoxy grout, above- ground.
 - a. Tile Type: Non-large format floor tile as indicated.
 - b. Thinset Mortar: Modified dry-set mortar.
 - c. Grout: Water-cleanable epoxy grout.
 5. Tile Installation: TCNA F121 and ANSI A108.1A; waterproofing/crack isolation membrane on unbonded cement mortar bed, on- or above- grade.
 - a. Tile Type: Non-large format tile indicated over waterproof membrane.
 - b. Setting: Tile set with thinset dry-set bond coat over cured liquid-applied waterproof/crack isolation membrane bonded to mortar bed over unbonded cleavage membrane, sloped to drain, with total thickness to allow flush set tile in recessed concrete slab as indicated but not more than 2 inches. Turn up waterproofing at wall base at least 6 inches.
 - 1) Bond Coat: Thinset mortar compatible with waterproof membrane, either modified or unmodified as instructed by waterproofing manufacturer.
 - c. Grout: Water-cleanable epoxy grout.
 - d. At full-tiled shower, place mortar bed over loose laid shower pan membrane per ASTM D 4068 in lieu of cleavage membrane.
 6. Tile Installation: TCNA F121 (Modified), TCNA F114, and ANSI A108.1C; cement mortar bed on uncoupling membrane on waterproof membrane, on- or above- grade.
 - a. Tile Type: Any large format tile type.

- b. Setting: Tile set with thinset dry-set bond coat on uncoupling membrane set with dry-set bond coat over cured liquid-applied waterproof/crack isolation membrane bonded to unreinforced, 1/2- to 5/8-inch medium-set mortar bed, sloped to drain, with total thickness to allow flush set tile in recessed concrete slab as indicated but not more than 2 inches. Turn up waterproofing at wall base at least 6 inches.
 - 1) Bond Coat: Thinset mortar compatible with uncoupling membrane, either modified or unmodified as instructed by uncoupling membrane manufacturer.
 - c. Grout: Water-cleanable epoxy grout.
 - d. At full-tiled shower, place mortar bed over loose laid shower pan membrane per ASTM D 4068 in lieu of cleavage membrane.
7. Tile Installation: TCNA F122; thinset mortar on waterproof membrane, on- grade.
- a. Tile Type: Non-large format floor tile as indicated.
 - b. Setting: Tile thinset with bond coat on bonded waterproof/crack isolation membrane.
 - c. Grout: Water-cleanable epoxy grout.
8. Tile Installation: TCNA F122A; thinset mortar on waterproof membrane, above- grade.
- a. Tile Type: Non-large format floor tile as indicated.
 - b. Setting: Tile thinset with bond coat on bonded waterproof/crack isolation membrane.
 - c. Grout: Water-cleanable epoxy grout.
9. Tile Installation: TCNA F122/F-122A (Modified); thinset mortar on uncoupling membrane on waterproof membrane, on- / above- grade.
- a. Tile Type: Any large format tile type
 - b. Setting: Tile thinset with bond coat on uncoupling membrane set with bond coat on waterproof membrane.
 - 1) Bond Coat: Thinset mortar compatible with uncoupling membrane, either modified or unmodified as instructed by uncoupling membrane manufacturer.
 - c. Grout: Water-cleanable epoxy grout.
- C. Interior Wall Installations, Metal Studs or Furring:
- 1. TCNA W244C or W244F: Thinset mortar on cementitious backer units over vapor-retarder.
 - a. Tile Type: As indicated.
 - b. Thinset Mortar: Modified dry-set mortar.
 - c. Grout: High-performance grout.
 - 2. TCNA W245 : Thinset mortar on glass-mat, water-resistant gypsum backer board.
 - a. Ceramic Tile Type: As indicated.
 - b. Thinset Mortar: Modified dry-set mortar.
 - c. Grout: High-performance grout.
- D. Shower Receptor and Wall Installations, as occurs:
- 1. Tile Installation: TCNA B415; thinset mortar on cementitious backer units or fiber-cement backer board over vapor-retarder membrane.
 - a. Tile Type: Wall tile as indicated.
 - b. Thinset Mortar: Modified dry-set mortar.
 - c. Grout: High-performance grout with grout sealer or epoxy grout.
 - 2. Tile Installation : TCNA B420; thinset mortar on waterproof membrane over coated glass-mat, water-resistant gypsum backer board.
 - a. Tile Type: Wall tile as indicated.
 - b. Thinset Mortar: Modified dry-set mortar.
 - c. Grout: High-performance grout with grout sealer or epoxy grout at wet areas.

3. For tile walls with waterproofing, use fluid-applied waterproofing on tile backer board and allow to cure before setting tile with mortar bond coat. Lap over waterproofing at base.

END OF SECTION 093013

SECTION 095100 - SUSPENDED ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 COORDINATION

- A. Coordinate layout and installation of suspended ceilings and suspension systems with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies. Indicate locations on coordination drawings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Provide layout of suspended acoustical ceilings coordinated with other trades that will penetrate the ceiling panels or interfere with the installation and recessed or surface mounted devices located within the ceiling panels. Indicate method of suspension where interference exists.
 - 1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Suspended ceiling components.
 - b. Structural members to which suspension systems will be attached.
 - c. Size and location of initial access modules for panels.
 - d. Items penetrating finished ceiling including, but not limited to, the following:
 - 1) Lighting fixtures.
 - 2) Air outlets and inlets.
 - 3) Speakers.
 - 4) Sprinklers.
 - 5) AV/IT devices.
 - 6) Access panels.
- C. Samples for Initial Selection: For components with factory-applied finishes requiring selection.
- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
 - 1. Acoustical Panels: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- (150-mm-) long Samples of each type, finish, and color.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Evaluation Reports: Suspension system, perimeter seismic clips, and cast-in-place and post-installed anchors and fasteners shall have current evaluation reports provided by ICC or equivalent ANSI accredited certification agency.
- B. Provide the following upon request:
 - 1. Qualification Data: For testing agency and professional engineer.
 - 2. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
 - 3. Evaluation Reports: For each acoustical panel ceiling suspension system, perimeter seismic clips, and anchors and fastener types, from ICC-ES.
 - 4. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.
- B. Basis-of-Design Products: Subject to compliance with requirements, provide products listed in the drawings as manufactured by the following:
 - 1. Armstrong Commercial Products, or comparable by one of the following:
 - a. CertainTeed, a Saint Goban Company
 - b. USG Corp

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E 1264.
 - 2. Smoke-Developed Index: 450 or less.

2.3 SUSPENDED ACOUSTICAL CEILING PANELS (CLG-1, CLG-2 and CLG-6)

- A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated on Drawings.
1. Edge: As indicated on Drawings according to manufacturer's product designation.
 2. Color: As indicated.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.
1. Classification: Heavy-duty
 2. Color: As indicated.

2.4 INTEGRATED CEILING SYSTEMS (CLG-4)

- A. Integrated Ceiling: Subject to compliance with requirements, provide products from Armstrong World Industries, Inc indicated on Drawings, or Architect approved equal from other acceptable manufacturers listed.
1. Integrated Ceiling System: Armstrong TechZone as indicated on Drawings.
 2. Panel Product: As indicated.
 3. Integrated Components: As indicated on Drawings, including lighting, diffusers, fire sprinklers, and other items indicated.
 4. Accessories: Linear lighting yokes, clips, transition components, and shadowline perimeter wall angles. Provide manufacturer's standard components and the following where indicated:
 - a. Armstrong Window Shade Pocket AXP355s
 - b. Armstrong Axiom Transition 6" AXTR6STR
 5. Other acceptable manufacturers:
 - a. CertainTeed Corporation.
 - b. United States Gypsum Company.

2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Cast-in-place or postinstalled expansion and bonded anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B 633, Class SC 1 (mild) service condition.
 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
 3. Provide attachment devices with current ICC Evaluation Service Report (ESR) acceptable to authority having jurisdiction.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than the following diameter wire.
 - a. Strength: 90 lbs, minimum strength of vertical wire connection device to structure.
 - b. Size: Minimum.
 - 1) Hanger Wire Size: 0.106 inch (No. 12-gauge diameter wire).
 - 2) Seismic Bracing Wire Size: 0.106 inch (No. 12-gauge diameter wire).
 - 3) Slack Safety Wire Size: 0.106 inch (No. 12-gauge diameter wire).
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A 653, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
- F. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.
- G. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
 - a. Seismic Requirements: Provide (50 mm) manufacturer's seismic perimeter clips used with standard nominal 7/8-inch (22 mm) wall angles, with current ICC Evaluation Service Report (ESR) acceptable to authority having jurisdiction.
 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly with 2-inch (50 mm) oversize ring.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
 1. Basis-of-Design Products: Armstrong Axiom; sizes as indicated.
 2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C 635 and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

- A. General: Install suspended acoustical ceilings according to ASTM C 636, manufacturer's written instructions, recommendations of CISCA's "Ceiling Systems Handbook," and the following seismic design requirements.
 - 1. Seismic Design Requirements: Install in accordance with the following:
 - a. ASTM E 580/E580M Section 5 for Seismic Design Categories D, E, and F, including applicable ASCE 7 requirements.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means. Maximum splay (plumb) of vertical hanger wires shall be 1 in 6.
 - 3. Provide horizontal restraint (splay wires or rigid bracing) within 2 inches of intersection and splayed 90 deg apart at 45 degree angles for areas over 1000 sq. ft.
 - 4. Provide compression posts (struts) 12 inches on center in both directions starting at 6 inches from walls.
 - 5. Splay bracing connection strength shall not be less than 250 lbs.
 - 6. Provide seismic separation joints for areas larger than 2500 sq. ft. and with length to width ratio less than or equal to 4:1.
 - 7. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 8. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 9. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

10. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 11. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 12. Do not attach hangers to steel deck tabs.
 13. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 14. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 15. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
 16. Provide rigid bracing for ceiling plane elevation changes.
 17. Partition bracing shall be independent of ceiling splay bracing.
- C. Light Fixtures:
1. Mechanically attach light fixtures to grid according to NEC 410. Provide two mechanical attachments per fixture unless independently supported.
 2. Attach surface-mounted fixtures attached to grid with positive clamping devices connected to the structure or vertical hanger wires.
 3. Directly support pendant-hung fixtures from structure with 9-gauge wire.
 4. Rigid lay-in or recessed can light fixtures:
 - a. Less than 10 lbs: Provide minimum one wire from fixture to structure.
 - b. 10 to 56 lbs: Provide two wires from fixture to structure.
 - c. Greater than 56 lbs: Support fixture directly to structure with approved hangers.
 - d. Rigid conduit attached to light fixtures is permitted, unless otherwise indicated.
- D. Other Services:
1. Air Terminals:
 - a. Less than 20 lbs: Attach positively to grid.
 - b. 20 to 56 lbs: Attach positively to grid and provide two 12-gauge wire hangers from fixture to structure.
 - c. Greater than 56 lbs: Support fixture directly to structure with approved hangers.
 2. Sprinkler heads and other penetrations: Minimum 2 inch diameter opening or use flexible sprinkler hose fitting, unless otherwise indicated.
 3. Cable trays and electrical conduit shall be independently supported and braced.
- E. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- F. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Install perimeter hanger wires not more than 8 inches from adjacent walls.
 2. Install stabilizer bars at perimeter tee ends to prevent spreading.
 3. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 4. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends. Miter corners accurately and connect securely.
 5. Do not use exposed fasteners, including pop rivets, on moldings and trim.
 6. Provide perimeter clearances required for seismic reactions.
- G. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

- H. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
 - 1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 - 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 - 3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 - 4. Install seismic clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.
 - 5. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: University will engage a qualified special inspector to perform the following special inspections:
 - 1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.
- B. Testing Agency: University will engage a qualified testing agency to perform tests and inspections.
- C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
 - 1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
 - 2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 095426 - SUSPENDED WOOD CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wood-veneer, flat-perforated-panel ceilings. (CLG-3)

1.2 COORDINATION

- A. Coordinate layout and installation of wood ceilings and suspension systems with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
- C. Shop Drawings: For suspended wood ceilings.
 - 1. Include reflected ceiling plans, sections, and details, drawn to scale, showing the following:
 - a. Wood ceiling patterns and joints.
 - b. Ceiling suspension members.
 - c. Method of attaching hangers to building structure and locations of cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - d. Ceiling-mounted items including, but not limited to, light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
 - e. Ceiling perimeter and penetrations through ceiling; trim and moldings.
- D. Samples for Verification: For the following products:
 - 1. Wood Ceilings: 12-inch- (305-mm-) long by 12-inch- (305-mm-) wide or full-width Samples of each type, color, and finish.
 - 2. Suspension-System Members: 12-inch- (305-mm-) long Sample of each type.
 - 3. Exposed Molding and Trim: 12-inch- (305-mm-) long Samples of each type, color, and finish.
 - 4. Sound Absorbers: 12 inches (305 mm) long by full width.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by National Voluntary Laboratory Accreditation Program for testing indicated.
- B. Provide the following upon request:
 - 1. Qualification Data: For testing agency and professional engineer.
 - 2. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.

3. Evaluation Reports: For each acoustical panel ceiling suspension system, perimeter seismic clips, and anchors and fastener types, from ICC-ES.
4. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ceiling components and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
 1. Store materials flat and level, raised from the floor.
- B. Handle ceiling components and accessories in a manner that prevents damage.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install interior ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
 1. Store and acclimatize wood products in the spaces where they will be installed for a minimum of 72 hours immediately before ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Criteria: Provide suspended wood ceilings designed and installed to withstand the effects of earthquake motions in accordance with ASCE/SEI 7 and requirements of authorities having jurisdiction.
- B. Certified Wood: Wood products shall comply with requirements of ASTM D7612-10 (FSC, SFI, ATSM, CSA or PEFC certifications are acceptable).

2.2 WOOD-VENEER, FLAT-PANEL CEILINGS

- A. Wood Panels (CLG-3): Manufacturer's standard panels consisting of wood veneer bonded to both faces of composite-wood core with exposed edges banded with the same veneer finish as the face with manufacturer's standard black finish Insert requirements.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong World Industries, Inc.
 - b. ASI Architectural.
 - c. USG Corporation.
 2. Surface-Burning Characteristics: Provide products with the following characteristics when tested in accordance with ASTM E84:
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 450 Insert value or less.
 3. Veneer Face Grade: Manufacturer's standard.
 4. Veneer Species: As indicated.
 5. Veneer Cut: Manufacturer's standard.
 6. Panel Perforation Pattern: As indicated by manufacturers designation.
 7. Panel NRC Rating: Not less than 0.65 when tested in accordance with ASTM C423.
 8. CAC: Not less than 37.

9. Acoustical Backing: Manufacturer's standard to provide NRC rating indicated for perforation pattern indicated, with flame-spread index of 25 or less and smoke-developed index of 450 or less as determined by testing in accordance with ASTM E84.
 10. Panel Surface Pattern: As indicated by manufacturer's designation.
 11. Panel Module: 24 by 48 inches (610 by 1219 mm).
 12. Panel Depth: 3/4 inch (19 mm).
 13. Panel Edges: Manufacturer's standard for 9/16 inch square, tegular grid installation.
 14. Veneer Adhesive: Manufacturer's standard that complies with "Performance Requirements" Article.
 15. Factory Finish: Manufacturer's standard finish; applied on every wood surface.
 - a. Type: Clear.
 - b. Gloss: Manufacturer's standard.
- B. Wood-Panel Accessories: Wood-panel manufacturer's accessories required to provide a complete installation of ceiling in accordance with manufacturer's written installation instructions.
1. Attachment Clips: Manufacturer's standard screw attached to back face of panels with square-cut edges to produce concealed-grid installation and allowing downward removal of ceiling panels.
 2. Safety Clips: Manufacturer's standard to prevent panels from dropping when disengaged from the suspension system.
 3. Safety Cables: Manufacturer's standard to prevent panels from falling to floor in event of grid failure.
 4. Border Clips: Manufacturer's standard angle type.
 5. Grid-Stabilizer Clips: Manufacturer's standard for oversize panels.
 6. Panel-Fixing Clip or Bracket: Manufacturer's standard that positively secures border and cut panels to the suspension system, so they cannot be removed from below.
 7. Veneer Edge Banding: Manufacturer's standard matching panels for treating cut edges; with pressure-sensitive adhesive backing.
 8. Wood-Board Edge Trim: Manufacturer's standard with core, veneer, and finish matching panel, complete with splice plates, clips, and brackets required for a complete installation in accordance with manufacturer's written instructions.
 - a. Board Width: 6 inches (152 mm).
 - b. Board Depth: 3/4 inch (19 mm).
- C. Grid Suspension System: ASTM C635/C635M; recommended in writing by ceiling and suspension-system manufacturers for applications indicated; main- and cross-runner system complete with suspension-system components required to support ceiling units and other ceiling-supported construction.
1. Structural Classification: Heavy-duty system.
 2. Face Width: 9/16 inch (14 mm).
 3. Finish: Flat black.
- D. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim channels of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, cross-T/main beam interface, and alignment, hanging, adjustment and attachment clips, and other connector and holddown clips, complying with seismic design requirements.
1. Basis-of-Design Products: Armstrong Axiom.
 - a. Axiom Straight Perimeter Trim, 2 inches; No. AX2STR
 - b. Axiom Straight Perimeter Trim, 8 inches; No. AX8STR
 2. Baked-Polyester: Trim manufacturer's standard. Comply with coting manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - a. Colors and Patterns: As selected by Architect from manufacturer's available colors and patterns.
 3. Warranty Period:
 - a. Perimeter Trim Components: Ten (10) years from date of substantial completion.

2.3 SUSPENSION-SYSTEM HANGERS, BRACES, AND TIES

- A. Attachment Devices: Size for 5 times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.
1. Cast-in-Place and Postinstalled Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 Insert safety factor times that imposed by ceiling construction as determined by testing in accordance with ASTM E488/E488M or ASTM E1512, as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Cast-in-place Postinstalled expansion Postinstalled bonded anchors.
 - b. Corrosion Protection:
 - 1) Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 Insert safety factor times that imposed by ceiling construction as determined by testing in accordance with ASTM E1190 conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung is less than yield stress of wire, but provide not less than 0.106-inch- (2.7-mm-) 0.135-inch- (3.4-mm-) Insert dimension diameter wire.
- C. Rods and Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed from 0.04-inch- (1.0-mm-) thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
- E. Seismic Stabilizer Bars: Grid-suspension-system manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- F. Seismic Struts: Suspension-system manufacturer's standard compression struts designed to accommodate seismic forces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which suspended wood ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage, and with requirements for installation tolerances and other conditions affecting performance of suspended wood ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of suspended wood ceilings.
1. Balance border widths at opposite edges of each ceiling.
 2. Avoid using less-than-half-width units.

3.3 INSTALLATION OF SUSPENDED WOOD CEILINGS

- A. Comply with ASTM C636/C636M and seismic requirement indicated, in accordance with manufacturer's written instructions and Cisca's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns in 3 inches (76 mm). Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, power-actuated fasteners, or postinstalled mechanical or adhesive anchors that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches (1219 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (203 mm) from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Light Fixtures:
1. Mechanically attach light fixtures to grid according to NEC 410. Provide two mechanical attachments per fixture unless independently supported.
 2. Attach surface-mounted fixtures attached to grid with positive clamping devices connected to the structure or vertical hanger wires.
 3. Rigid lay-in or recessed can light fixtures:
 - a. Less than 10 lbs: Provide minimum one wire from fixture to structure.
 - b. 10 to 56 lbs: Provide two wires from fixture to structure.
 - c. Greater than 56 lbs: Support fixture directly to structure with approved hangers.
 - d. Rigid conduit attached to light fixtures is permitted, unless otherwise indicated.
- D. Other Services:
1. Air Terminals:
 - a. Less than 20 lbs: Attach positively to grid.
 - b. 20 to 56 lbs: Attach positively to grid and provide two 12-gauge wire hangers from fixture to structure.
 - c. Greater than 56 lbs: Support fixture directly to structure with approved hangers.
 2. Sprinkler heads and other penetrations: Minimum 2 inch diameter opening or use flexible sprinkler hose fitting, unless otherwise indicated.
 3. Cable trays and electrical conduit shall be independently supported and braced.

- E. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns in 1-1/2 inches (38 mm). Suspend bracing from building's structural members as required for hangers and without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- F. Install edge moldings and trim at perimeter of ceiling area and where necessary to conceal edges and ends of wood units.
 - 1. Screw-attach metal moldings to substrate at intervals of not more than 16 inches (406 mm) o.c. and not more than 3 inches (76 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.7 m). Miter corners accurately and connect securely.
 - 2. Do not use exposed fasteners on moldings and trim.
- G. Grid Suspension Systems: Space main beams at 48 inches (1219 mm) o.c.
 - 1. Install cross tees to form modules sized in accordance with manufacturer's written installation instructions.
 - 2. Remove and replace dented, bent, or kinked members.
- H. Install wood components and accessories in accordance with manufacturer's written instructions and to accommodate natural expansion and contraction of wood products resulting from fluctuations in humidity.
- I. Cut wood components for accurate fit at borders and at interruptions and penetrations by other work through ceilings.
 - 1. Stiffen edges of cut wood components as required to eliminate variations in flatness.
- J. Install wood components in coordination with suspension system and moldings and trim.
- K. Install field-constructed access panels in locations indicated on Drawings.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: University will engage a qualified special inspector to perform the following special inspections:
 - 1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.
- B. Testing Agency: University will engage a qualified testing agency to perform tests and inspections.
- C. Tests and Inspections: Testing and inspecting of completed installations of ceiling hangers, anchors, and fasteners to take place in successive stages, in test areas and using methods as follows. Do not proceed with installations of ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.
 - 1. Test Areas: Test installation of ceiling suspension systems on each floor when installation has reached 20 percent completion but before wood ceilings have been installed.
 - a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
 - b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 CLEANING

- A. Clean exposed surfaces of ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented units.

END OF SECTION 095426

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Resilient wall base. (WB-#)
 - 2. Resilient molding accessories.
 - 3. Resilient stair accessories. (RF-8)
 - 4. Metal edging.

- B. Related Requirements:
 - 1. Section 096516 "Resilient Sheet Flooring" and Section 096723 "Resinous Flooring" for integral covered base.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples.
- C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.4 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE - WB-1 and WB-2

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following, unless otherwise indicated:
 - 1. Armstrong World Industries, Inc.
 - 2. Burke Flooring, A Mannington Commercial Company

3. Johnsonite; A Tarkett Company
 4. Nora Systems, Inc.
- B. Basis-of-Design Product: As indicated; refer to Finish Schedule on Drawings. Provide product indicated, or Architect approved equal by one of the other listed manufacturers.
- C. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
1. Group: I (solid, homogeneous).
 2. Style and Location:
 - a. Coved: For hard and resilient flooring with cove.
 - 1) Height: 4 inches
 - b. Straight (Topset): For carpeting without cove.
 - 1) Height: 4 inches
- D. Thickness: 0.125 inch.
- E. Lengths: Cut lengths 48 inches long or coils in manufacturer's standard length.
- F. Outside Corners: Preformed.
- G. Inside Corners: Job formed or preformed.
- H. Colors: As indicated; refer to Finish schedule on Drawings.

2.2 RUBBER MOLDING ACCESSORY

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Armstrong World Industries, Inc.
 2. Burke Flooring, A Mannington Commercial Company
 3. Johnsonite; A Tarkett Company
 4. Nora Systems, Inc.
- B. Description: Reducer strips for resilient flooring and carpet, transition strips, as required.
- C. Colors and Profiles: As selected by Architect from manufacturer's available colors and profiles.

2.3 RUBBER STAIR ACCESSORIES - RF-8

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following, unless otherwise indicated:
1. Armstrong World Industries, Inc.
 2. Burke Flooring, A Mannington Commercial Company
 3. Johnsonite; A Tarkett Company
 4. Nora Systems, Inc.
- C. Basis-of-Design Product: As indicated; refer to Finish Schedule on Drawings. Provide product indicated, or Architect approved equal by one of the other listed manufacturers.

- D. Stair Treads: ASTM F 2169.
 - 1. Type: TS (rubber, vulcanized thermoset)
 - 2. Class: 2 (pattern; embossed, grooved, or ribbed).
 - 3. Group: 2 (with contrasting color for the visually impaired).
 - 4. Nosing Style: Square.
 - 5. Nosing Height: 2 inches
 - 6. Thickness: 2 mm and tapered to back edge
 - 7. Size: Lengths and depths to fit each stair tread in one piece or, for treads exceeding maximum lengths manufactured, in equal-length units.

- E. Separate Risers: Smooth, flat; in height that fully covers substrate; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
 - 1. Style: Toeless, by length matching treads.
 - 2. Thickness: Manufacturer's standard]

- F. Landing Tile: Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads

- G. Locations: Provide rubber stair accessories in areas indicated

- H. Colors and Patterns: As indicated.

2.4 METAL EDGE STRIPS

- A. Metal Edge Strips: Metal edge protection and transitions strips of width shown, of height required to protect exposed edges of resilient flooring, and maximum available lengths to minimize running joints; finish and color as indicated on Drawings.
 - 1. Basis of Design Manufacturers: Subject to compliance with requirements, provide basis-of-design shapes indicated as manufactured by the following:
 - a. Schluter Systems, LP, or comparable by one of the following:
 - 1) Blanke Corporation.
 - 2) Progress Profiles.
 - 2. Basis-of-Design Products: Style and sizes as indicated on Drawings.

2.5 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less and 60 g/L or less for rubber stair treads.

- C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Do not install resilient products until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- C. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing flooring accessories.
- B. Flooring Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed. Install metal edge strips where indicate don Drawings.
- C. Resilient Stair Accessories:
 - 1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - 2. Tightly adhere to substrates throughout length of each piece.
 - 3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

SECTION 096516 - RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes resilient sheet flooring. (RF-#)
- B. Related Requirements:
 - 1. Section 090561.13 "Moisture Vapor Emission Control" for remediation of concrete floors that exceed moisture vapor limitations
 - 2. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with resilient flooring.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of flooring. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch sections of each different color and pattern of resilient sheet flooring required.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.
- D. Product Schedule: For flooring. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Certifications: Submit a certification signed by the manufacturer and installer stating that the resilient flooring has been installed as specified and in accordance with fire-test response characteristics.
- B. Field Test Reports: For concrete subfloor moisture and alkalinity field test results. Provide results to Architect and resilient flooring manufacturers.
- C. Certification: Signed by manufacturer and installer that subfloors meet or exceed requirements of product installation for moisture content and alkalinity.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of resilient sheet flooring to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Resilient Sheet Flooring: Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, in roll form and in full roll width for each type, color, and pattern of flooring installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.
- B. Provide the following upon request;
 - 1. Qualification Data: For Installer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient sheet flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store rolls upright.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive resilient sheet flooring during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during resilient sheet flooring installation.
- D. Close spaces to traffic for 48 hours after resilient sheet flooring installation.
- E. Install resilient sheet flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. FloorScore Compliance: Resilient flooring shall comply with requirements of FloorScore certification.

2.2 RUBBER SHEET FLOORING - RF-3 and RF-4

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide product listed on Drawings by the following:
 - 1. Nora Systems, Inc, or Architect approved equal by one of the following:
 - a. Armstrong World Industries, Inc.
 - b. Mannington Commercial.
- B. Basis-of-Design Products: As indicated; refer to Finish Schedule on Drawings.

- C. Construction: Homogeneous vulcanized rubber compound with a marbleized design.
- D. Thickness: 3 mm
- E. Surface: Smooth
- F. Seamless-Installation Method: Provide heat welded seams where indicated on Drawings.
- G. Integral Cove: Provide integral cove base where indicated on Drawings. Chemical weld outside and inside corners. Height as indicated.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
 - 2. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Seamless-Installation Accessories:
 - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Color: As selected by Architect from manufacturer's full range.
- D. Integral-Flash-Cove-Base Accessories:
 - 1. Cove Strip: 1-inch radius provided or approved by resilient sheet flooring manufacturer.
 - 2. Cap and End Stop Strip: Square metal, vinyl, or rubber cap provided or approved by resilient sheet flooring manufacturer. Type, material, and color as selected by Architect. Refer to Section 096513.
 - 3. Corners: Chemically bond inside and outside corners.
 - a. Chemical-Bonding Compound: Manufacturer's product for chemically bonding cove base seams at corners.
 - 1) Bonding compound shall have a VOC content of 510 g/L or less.
 - 2) Bonding compound shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
 - 3. Moisture Testing: Proceed with installation only after substrates pass testing according to resilient sheet flooring manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
 - 4. Alkalinity and Adhesion Testing: Perform tests recommended by resilient flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH unless more stringent is required by resilient flooring manufacturer.
 - 5. If tests exceed stated limits, apply approved moisture vapor emission control product complying with ASTM F-3010 in accordance with Section 090561.13 and allow to cure before installing resilient sheet flooring.
 - 6. Submit test reports to Architect and flooring manufacturer.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient sheet flooring until it is the same temperature as the space where it is to be installed.
 - 1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 RESILIENT SHEET FLOORING INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient sheet flooring.
- B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.
- C. Lay out resilient sheet flooring as follows:
 - 1. Maintain uniformity of flooring direction.
 - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
 - 3. Match edges of flooring for color shading at seams.
 - 4. Avoid cross seams.
- D. Scribe, cut, and fit resilient sheet flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including pipes, outlets, and door frames.

- E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings. Install under permanent fixed cabinets and casework.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.
- H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Seamless Installation:
 - 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless flooring. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
- J. Integral-Flash-Cove Base: Cove resilient sheet flooring to dimension indicated up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.
 - 1. Chemical weld inside and outside corners.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient sheet flooring.
- B. Perform the following operations immediately after completing resilient sheet flooring installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect resilient sheet flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient sheet flooring until Substantial Completion.

END OF SECTION

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Resilient tile flooring. (RF-#)
- B. Related Requirements:
 - 1. Section 090561.13 "Moisture Vapor Emission Control" for remediation of concrete floors that exceed moisture vapor limitations.
 - 2. Section 096513 "Resilient Base and Accessories" for resilient base, reducer strips, stair treads, and other accessories installed with resilient floor coverings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of flooring. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. Samples for Verification: Full-size units of each color and pattern of floor tile required.
- D. Product Schedule: For flooring. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Certifications: Submit a certification signed by the manufacturer and installer stating that the resilient flooring has been installed as specified and in accordance with fire-test response characteristics.
- B. Field Test Reports: For concrete subfloor moisture and alkalinity field test results. Provide results to Architect and resilient flooring manufacturers.
- C. Certification: Submit a certification signed by manufacturer and installer that subfloors meet or exceed requirements of product installation for moisture content and alkalinity.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

B. Provide the following upon request:

1. Qualification Data: For Installer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.8 FIELD CONDITIONS

- A. 48 hours before installation.
- B. During installation.
- C. 48 hours after installation.
- D. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- E. Close spaces to traffic during floor tile installation.
- F. Close spaces to traffic for 48 hours after floor tile installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. FloorScore Compliance: Resilient flooring shall comply with requirements of FloorScore certification.

2.2 LUXURY VINYL TILE - RF-1 and RF-2

- A. Manufacturers: Subject to compliance with requirements, provide products indicated on Drawing by the following:
 1. Mowhak Group, or Architect approved equal by one of the following:
 - a. Armstrong World Industires, Inc.
 - b. Mannington Commercial
- B. Basis-of-Design Product: As indicated; refer to Finish Schedule on Drawings.
- C. Standard: ASTM F1700, Class III printed film vinyl tile.
- D. Surface: Embossed
- E. Collection/Color: As indicated.

- F. Size: 18 by 36 inches
- G. Thickness: Not less than 5 mm overall with 20 mil wear layer.
- H. Warranty: Manufacturer's 20 year Commercial

2.3 RUBBER TILE FLOORING - RF-5

- A. Manufacturers: Subject to compliance with requirements, provide products indicated on Drawing by the following:
 - 1. Tarkett North America, or Architect approved equal by one of the following:
 - a. Armstrong World Industires, Inc.
 - b. Mannington Commercial
- B. Basis-of-Design Products: As indicated; refer to Finish Schedule on Drawings.
- C. Tile Standard: ASTM F 1344, Class I-B, homogeneous rubber tile, through mottled.
- D. Wearing Surface: Speckled
- E. Thickness: As standard with manufacturer for product indicated.
- F. Size, Nominal: 24 inches by 24 inches.
- G. Color: As indicated.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 60 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to resilient tile flooring manufacturer's written instructions to ensure adhesion of resilient tile flooring.
- B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient tile flooring manufacturer. Do not use solvents.
 3. Moisture Testing: Proceed with installation only after substrates pass testing according to resilient tile flooring manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
 4. Alkalinity and Adhesion Testing: Perform tests recommended by resilient tile flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH unless more stringent is required by resilient flooring manufacturer.
 5. If tests exceed stated limits, apply approved moisture vapor emission control product complying with ASTM F-3010 in accordance with Section 090561.13 and allow to cure before installing resilient tile flooring.
 6. Submit test reports to Architect and flooring manufacturer.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient tile flooring until it is the same temperature as the space where it is to be installed.
1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 RESILIENT TILE FLOORING INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient tile flooring.
- B. Allow resilient tile to acclimate and stabilize before cutting and fitting.
- C. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
- D. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings. Install under permanent fixed cabinets and casework.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 1. Remove adhesive and other blemishes from exposed surfaces.
 2. Sweep and vacuum surfaces thoroughly.
 3. Damp-mop surfaces to remove marks and soil.

- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

END OF SECTION

SECTION 096536 - STATIC-CONTROL RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Static-control, vinyl floor tile. (RF-6)

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of static-control resilient flooring. Include floor-covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
 - 2. Show locations of inscribed maintenance floor tiles in conductive, solid vinyl floor tile installation areas.
 - 3. Show grounding locations of grounding strips and connections.
- C. Samples: For each type of static-control resilient flooring and in each color, pattern, and texture required, in manufacturer's standard size, but not less than 6 by 9 inches.
- D. Product Schedule: For static-control resilient flooring. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Certifications: Submit a certification signed by the manufacturer and installer stating that the resilient flooring has been installed as specified and in accordance with fire-test response characteristics.
- B. Field Test Reports: For concrete subfloor moisture and alkalinity field test results. Provide results to Architect and resilient flooring manufacturers.
- C. Certification: Submit a certification signed by manufacturer and installer that subfloors meet or exceed requirements of product installation for moisture content and alkalinity.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of static-control resilient flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in installation techniques required by manufacturer for specified static-control resilient flooring.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required for specified products.
- B. Provide the following upon request:
 - 1. Qualification Data: For Installer.
 - 2. Product Test Reports: For static-control resilient flooring, for tests performed by a qualified testing agency.
 - 3. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store static-control resilient flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended in writing by manufacturer, but not less than 50 deg F or more than 90 deg F.
 - 1. Floor Tile: Store on flat surfaces.
 - 2. Sheet Floor Covering: Store rolls upright.

1.7 PROJECT CONDITIONS

- A. Maintain ambient temperatures in spaces to receive static-control resilient flooring within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, during the following time periods:
 - 1. Period recommended in writing by manufacturer before installation.
 - 2. During installation.
 - 3. Period recommended in writing by manufacturer after installation.
- B. Until Substantial Completion, maintain ambient temperatures in installation areas within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during static-control resilient flooring installation.
- D. Close spaces to traffic for period recommended in writing by manufacturer after static-control resilient flooring installation.
- E. Install static-control resilient flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 STATIC-CONTROL, SOLID VINYL FLOOR TILE - RF-6

- A. Manufacturers: Subject to compliance with requirements, provide products indicated on Drawing by the following:
 - 1. Tarkett North America, or Architect approved equal by one of the following:
 - a. Armstrong World Industires, Inc.
 - b. Mannington Commercial
- B. Basis-of-Design Products: As indicated; refer to Finish Schedule on Drawings.
- C. Source Limitations: Obtain floor tile from single source from single manufacturer.
- D. Static-Control Properties: As determined by testing identical products in accordance with test method indicated by an independent testing and inspecting agency.
 - 1. Electrical Resistance:
 - a. Material: Point-to-point and point-to-ground resistances between 10^6 ohms and 10^9 ohms when tested in accordance with ASTM F150.
 - b. Material in Combination with a Person: Average resistance of 10^9 ohms when tested in accordance with ESD STM97.1.
 - 2. Static Generation:

- a. ESD STM97.2: Less than 100 V when tested at 12 percent relative humidity with static-control footwear.
- E. Critical Radiant Flux: 0.22 W/sq. cm or greater when tested in accordance with ASTM E648 or NFPA 253.
- F. Static Coefficient of Friction (ASTM D 2047): ≥ 0.5 SCOF
- G. Construction: ASTM F1700, Class I (monolithic), Type A (smooth surface).
- H. Thickness: Manufacturer's standard, but not less than 0.08 inch.
- I. Size: 24 by 24 inches.
- J. Seaming Method: Manufacturer's standard.
- K. Colors and Patterns: As indicated.
- L. Maintenance Floor Tiles: Special floor tiles inscribed "Conductive floor. Do not wax."
- M. Commercial Warranty: 20 year

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified portland cement or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Static-Control Adhesive: Provided or approved by manufacturer; type that maintains electrical continuity of floor-covering system to ground connection.
- C. Grounding Strips: Provided or approved by manufacturer; type and size that maintains electrical continuity of floor-covering system to ground connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer and manufacturer's representative present, for compliance with requirements for conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with installation or static-control characteristics of floor coverings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates in accordance with manufacturer's written instructions and with oversight by manufacturer's representative to ensure successful installation of static-control resilient flooring and electrical continuity of floor-covering systems.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient tile flooring manufacturer. Do not use solvents.
 3. Moisture Testing: Proceed with installation only after substrates pass testing according to resilient tile flooring manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
 4. Alkalinity and Adhesion Testing: Perform tests recommended by resilient tile flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 7 or more than 9 pH unless more stringent is required by resilient flooring manufacturer.
 5. If tests exceed stated limits, apply approved moisture vapor emission control product complying with ASTM F-3010 in accordance with Section 090561.13 and allow to cure before installing resilient tile flooring.
 6. Submit test reports to Architect and flooring manufacturer.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install static-control resilient flooring until it is same temperature as space where it is to be installed.
1. Move static-control resilient flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum substrates to be covered by static-control resilient flooring immediately before installation.

3.3 INSTALLATION, GENERAL

- A. Install static-control resilient flooring in accordance with manufacturer's written instructions and with oversight by manufacturer's representative.
- B. Extend grounding strips beyond perimeter of static-control resilient floor-covering surfaces to ground connections.
1. For adhesively installed flooring, embed grounding strips in static-control adhesive.
- C. Scribe, cut, and fit static-control resilient flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
1. Extend static-control resilient flooring below built-in items and permanent, but movable, items that allow for a flexible layout where indicated on Drawings.
- D. Extend static-control resilient flooring into toe spaces, door reveals, closets, and similar openings.
- E. Extend static-control resilient flooring to center of door openings where flooring or color transitions occur.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on static-control resilient flooring as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- G. Install static-control resilient flooring on covers for telephone and electrical ducts, and similar items in installation areas. Maintain overall continuity of color and pattern with pieces of static-control resilient flooring installed on covers. Tightly adhere static-control resilient flooring edges to substrates that abut covers and to cover perimeters.

- H. Adhesive Installation: Adhere static-control resilient flooring to substrates using a full spread of static-control adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 INSTALLATION OF FLOOR TILE

- A. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half floor tile at perimeter.
 - 1. Lay floor tiles in pattern indicated on Drawings.
- B. Match floor tiles for color and pattern by selecting floor tiles from cartons in same sequence as manufactured and packaged if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.
- C. In each space where conductive, solid vinyl floor tile is installed, install maintenance floor tile identifying conductive floor tile in locations approved by Architect.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: District will engage a qualified testing agency to test electrical resistance of static-control resilient flooring in accordance with ASTM F150 for compliance with requirements.
 - 1. Arrange for testing after the following:
 - a. Static-control adhesives have fully cured.
 - b. Static-control resilient flooring has stabilized to ambient conditions.
 - c. Ground connections are completed.
- B. Static-control resilient flooring will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of static-control resilient flooring.
- B. Perform the following operations immediately after completing static-control resilient flooring:
 - 1. Remove static-control adhesive from exposed surfaces.
 - 2. Remove dirt and blemishes from exposed surfaces.
 - 3. Sweep and vacuum surfaces thoroughly.
 - 4. Damp-mop surfaces to remove marks and soil.
- C. Protect static-control resilient flooring from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
 - 1. Do not wax static-control resilient flooring.
 - 2. If recommended in writing by manufacturer, apply protective static-control floor polish formulated to maintain or enhance floor covering's electrical properties. Before polishing, do the following:
 - a. Ensure that static-control resilient flooring surfaces are free from soil, static-control adhesive, and surface blemishes.
 - b. Verify that both floor polish and its application method are approved by manufacturer and that floor polish will not leave an insulating film that reduces static-control resilient flooring's effectiveness for static control.
- D. Cover static-control resilient flooring and protect from rolling loads until Substantial Completion.

END OF SECTION 096536

SECTION 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Resinous flooring. (RF-#)
 - 2. Integral cove base accessories.
- B. Related Sections:
 - 1. Section 071800 "Traffic Coatings" for elastomeric flooring systems.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review manufacturer's written instructions for substrate preparation and environmental conditions affecting resinous flooring installation.
 - 2. Review details of integral cove bases.
 - 3. Review manufacturer's written instructions for installing resinous flooring systems.
 - 4. Review protection measures for adjacent construction and installed flooring, floor drainage requirements, curbs, base details, and so forth.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's technical data, installation instructions, chemical-resistance information, and recommendations for each resinous flooring component required.
- B. Samples for Initial Selection: For each type of exposed finish required.
- C. Samples for Verification: For each resinous flooring system required and for each color and texture selected, 6 inches square, applied to a rigid backing by Installer for this Project.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
 - 1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Apply full-thickness mockups on 96-inch- (2400-mm-) square floor area selected by Architect.
 - a. Include 96-inch (2400-mm) length of integral cove base with inside and outside corner as can be accomplished.
 - 2. Perform slip-resistance testing on mockup according to requirements in Field Quality Control Article. If flooring does not pass testing, remediate according to resinous flooring manufacturer's instructions until floors pass testing. Apply remediation procedures to final installation.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Provide the following upon request:

1. Qualification Data: For Installer.
2. Material Certificates: For each resinous flooring component.
3. Material Test Reports: For each resinous flooring system, by a qualified testing agency.
4. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring installation.
- C. Close spaces to traffic during resinous flooring installation and for 24 hours after installation unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. VOC Content of Liquid-Applied Resinous Coating Components: Not more than 100 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flammability: Self-extinguishing in accordance with ASTM D635.
- D. Dynamic Coefficient of Friction: Provide resinous flooring with dynamic coefficient of friction indicated as determined by testing identical products per ANSI A137.1/A326.3 DCOF AcuTest procedure.
1. Dynamic Coefficient of Friction (DCOF):
 - a. Intermittently wet (Chemical Waste Storage): Not less than 0.42 wet.
 - b. Normally wet/slippery (Cadaver room) Not less than 0.50 wet.

2.2 RESINOUS FLOORING - RF-7

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crossfield Products Corp.; Dex-o-Tex (Basis-of-Design)

- b. Stonhard, Inc. (Stonclad GS/Stonkote HT4 and StonClad UR/Stonchem 800)
- 2. Basis-of-Design Product: Crossfield Products, Dex-o-Tex; Posi-Tred O, pigmented epoxy coating
- B. Components listed below are the basis of design intent; all substitutions will be compared to this standard including resin chemistry, color, wearing surface, thickness, number of coats, and installation procedures, Contractor shall comply with all the requirements of the Specifications and all of the components required by the Specifications, whether or not such products are specifically listed.
- C. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.
- D. System Characteristics:
 - 1. Description: Two-component chemical-resistant pigmented epoxy with aluminum oxide broadcast over urethane slurry base coat.
 - 2. Color and Pattern: As indicated; refer to Finish Schedule on Drawings.
 - 3. Wearing Surface: Textured for slip resistance.
- E. Vapor Control Primer: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated if required for moisture emission control.
- F. Waterproofing Membrane: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.
 - 1. Product: Dex-O-Tex Cheminert SC Membrane, unless otherwise recommended.
- G. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended in writing by manufacturer for installation indicated.
- H. Slurry-Applied Urethane Cement Composition Mortar:
 - 1. Basis of Design: Dex-O-Tex Tek-Crete SL-B by Crossfield Products.
 - a. Coats: 1 coat for total thickness of 5/16 inch.
- I. Topcoat: Chemical, heat, and skid-resistant epoxy coating for application over prepared concrete.
 - 1. Basis of Design: Dex-O-Tex Posi-Tred O by Crossfield Products.
 - 2. Coats: 2 coats with dry film thickness not less than 10 mils per coat.
 - 3. Physical Properties:
 - a. Solids: 100 percent
 - b. Tensile Strength (ASTM C307): Not less than 1,200 psi.
 - c. Surface Hardness (ASTM D2240) 75-80 Durometer "D".
 - d. Resistance to Fungal Growth (ASTM G21): Passes, Rating 1, with additive.
 - e. VOC: Less than 5 g/L

2.3 ACCESSORIES

- A. Precast, Integral Cove Base: Contractor's option in lieu of field-formed cove bases. Impact-resistant, polymer-resin, cove base moldings with a grit profile to promote adhesion of resinous flooring and recommended in writing by resinous flooring manufacturer.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. SpeedCove, Inc., or equal as recommended by resinous flooring manufacturer.
 - 2. Radius Cove: Cove molding with approximately 1-inch (25-mm) radius for adhesive installation at floor-to-wall joint as substrate to receive resinous flooring system to form an integral cove base.

3. Radius Cove Base: Cove base molding that provides approximately 1-inch (25-mm) radius cove at floor-to-wall joint; for adhesive installation as substrate for resinous flooring system to form an integral cove base.
 - a. Preformed Inside and Outside Corners: Provide manufacturer's standard square inside and square outside corners.
- B. Installation Adhesive: As recommended in writing by accessory manufacturer.
 1. Adhesives: Do not use adhesives that contain urea formaldehyde.
 2. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Sealant: Manufacturer's recommended or produced by resinous flooring manufacturer for type of service and joint conditions indicated or required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements of ACI 311.4R for conditions affecting performance of the Work.
 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resinous flooring systems.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare and clean substrates in accordance with resinous flooring manufacturer's written instructions for substrate indicated to ensure adhesion.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 1. Roughen concrete substrates as follows:
 - a. Shot-blast or diamond-grind surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot and dust by vacuum pickup.
 - b. Comply with requirements in SSPC-SP 13/NACE No. 6, with a Concrete Surface Profile of 3 or greater in accordance with ICRI Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.
 2. Remove sufficient material to provide a sound surface, free of laitance, glaze, efflorescence, and any bond-inhibiting curing compounds or form release agents. Remove grease, oil, and other penetrating contaminants. Repair damaged and deteriorated concrete in accordance with resinous flooring manufacturer's written instructions. Leave surface free of dust, dirt, laitance, and efflorescence.
 3. Repair damaged and deteriorated concrete in accordance with ACI 546.R and resinous flooring manufacturer's written instructions.
 4. Moisture Testing: (304.8 sq. m) Perform no fewer than two tests in each installation area and with test areas evenly spaced in installation areas. Perform the following tests required by manufacturer:

- a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 5. Moisture vapor emission rates (MVER) in excess of either 3 lbs./1000 sq/ft/per 24 hr. period per ASTM F1869, or an RH in excess of 75%% per ASTM F2170 requires the application of Vapor Control Primers as instructed by manufacturer.
 6. Perform additional moisture tests recommended by manufacturer. When required, apply vapor control primer according to procedures as instructed by resinous flooring manufacturer. Proceed with application only after substrates pass testing.
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates in accordance with manufacturer's written instructions. Verify the substrate has proper levelness and flatness, and slope for drainage.
1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials in accordance with resinous flooring manufacturer's written instructions.
- E. Pre-Manufactured Integral Cove Base Accessories: Adhesively install precast accessories before applying flooring coats and in accordance with manufacturer's written instructions.
1. Integral Cove Base: 6 inches (100 mm) high, unless otherwise indicated.
- F. Field-Formed Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring coats. Apply in accordance with manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
1. Integral Cove Base: 6 inches high, unless otherwise indicated.
- G. Waterproofing Membrane: Apply Membrane in a 40 mil "neat" coat and allow to cure overnight. Apply a second 10 mil coat and broadcast with sand to rejection. Allow to cure.
1. Sweep off the surface and apply the urethane slurry basecoat directly to the broadcast surface.
 2. Verify proper surface profile per ICRI 310.25 CSP coupons. Perform water break test and tape dust cleanliness test per ISO 8502-3 to determine surface is acceptable to proceed.
 3. Apply waterproofing membrane to integral cove base substrates.

3.3 INSTALLATION

- A. Apply components of resinous flooring system in accordance with manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness specified.
1. Coordinate installation of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 2. Cure resinous flooring components in accordance with manufacturer's written instructions. Prevent contamination during installation and curing processes.
 3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
 4. Contractor shall keep daily logs recording the work performed and environmental conditions as required by the materials manufacturer.
- B. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness specified for flooring system.

- C. Topcoats: Apply topcoats in number of coats indicated for flooring system specified, to produce finish matching approved submittal sample, and at spreading rates recommended in writing by manufacturer, and to produce wearing surface specified.
 - 1. Aggregates: Broadcast aggregates at rate recommended in writing by manufacturer. After resin is cured, remove excess aggregates to provide surface texture indicated.

3.4 TERMINATIONS

- A. Chase edges to "lock" the flooring system into the concrete substrate along lines of termination.
- B. Penetration Treatment: Lap and seal the flooring system onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.

3.5 JOINTS AND CRACKS

- A. Treat control joints to bridge potential cracks and to maintain monolithic protection.
- B. Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.
- C. Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.6 FIELD QUALITY CONTROL

- A. Slip Resistance: Engage special testing agency to perform the following tests.
 - 1. Dynamic Coefficient of Friction (DCOF): A reading of not less than indicated for each wet/dry area indicated in Performance Requirements above shall be achieved and documented, as determined by a certified NFSI walkway auditor using the ANSI A137.1/A326.3 quality control test using a recognized tribometer.
 - a. Test once in each installation area under conditions indicated.
 - 2. Prepare test reports. Submit to Architect upon request.
- B. Material Sampling: University may, at University's discretion, at any time and any number of times during resinous flooring installation, require material samples for testing for compliance with requirements.
 - 1. University may engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
 - 3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reinstall flooring materials to comply with requirements.
- C. Core Sampling: At University's direction and at locations designated by University, take one core sample in each installation area, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

3.7 CURING AND PROTECTION

- A. Cure resinous flooring materials according to manufacturer's directions, taking care to prevent contamination during application stages and before completing curing process. Close application area for a minimum of 24 hours.
- B. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes modular carpet tile.
- B. Related Requirements:
 - 1. Section 090561.13 "Moisture Vapor Emission Control" for remediation of concrete floors that exceed moisture vapor limitations.
 - 2. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products. Not required for basis-of-design products.
- C. Shop Drawings: For carpet tile installation, plans showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Type of subfloor.
 - 4. Type of installation.
 - 5. Pattern of installation.
 - 6. Pattern type, location, and direction.
 - 7. Pile direction.
 - 8. Type, color, and location of insets and borders.
 - 9. Type, color, and location of edge, transition, and other accessory strips.
 - 10. Transition details to other flooring materials.
- D. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.
- E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Certification: Signed by manufacturer and installer that subfloors meet or exceed requirements of product installation for moisture content and alkalinity.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.

2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.
- B. Provide the following upon request:
 1. Qualification Data: For Installer.
 2. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Mockups: Build in-place mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 1. Build mockups for carpet tile including resilient base and accessories.
 - a. Size: Minimum 100 sq. ft. for each type, color and pattern in locations directed by Architect.
 2. Obtain Architect's approval for each product before proceeding with remaining Work of this Section.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

1.8 FIELD CONDITIONS

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements:
 1. CBC 804.3 - Testing and Identifications:

- a. Carpeting shall be tested by an agency in accordance with ASTM E648 or NFPA 253 and identified by a hang tag or other suitable method so as to identify the manufacturer or supplier and style, and shall indicate the carpet classification in accordance with CBC Section 804.2. Carpeting shall be tested as proposed for use. Test reports confirming the information provided in the manufacturer's product identification shall be furnished to the submitted upon request.
2. CBC 804.4.1 - Test Requirements:
 - a. Carpeting shall comply with the requirements of ASTM E648, and shall have a specific optical density smoke rating not to exceed 450 per ASTM E662.
- B. Fire-Test-Response Characteristics: As determined by testing identical carpeting applied with identical adhesives to substrates in accordance with test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
- C. Stain Resistance: Stain resistance properties shall be inherent. Topical Stain resistance treatment will not be acceptable. Stain Resistance properties shall be permanent and cannot be removed by commercial cleaning or abrasive wear and shall pass the AATCC 175 red dye 40 tests. Carpet is required to retain permanent stain protection against acid type spills for the life of the carpet as measured by General Services Administration (GSA) test for permanence SIN 31-8.
- D. Edge Ravel: Limited lifetime Warranty against Edge Ravel. Preference will be given to carpet manufacturers that do not require the edges of the carpet to be seam sealed to guarantee 20 years of edge unraveling.
- E. Tuft Bind: Wet: Limited Lifetime Warranty against zippering
- F. Color fastness-light/color: Carpet is required to resist color loss from light exposure for 10 years. Manufacturer is required to provide a 10-year warranty for colorfastness after exposure to light as measured by AATCC Test Method 16E- International Gray scale rating after 160 AFU's should be 4 or better.
- G. Colorfastness-ozone: Carpet will resist color loss from Atmospheric Contamination for 10 years. Carpet manufacturer is required to provide a 10-year warranty for colorfastness after exposure to atmospheric contaminates as measured by AATCC Test Method 129- Ozone minimum shade change rating after five cycles shall be no less than International Gray scale rating of 4 or better.
- H. Colorfastness-crocking: Rating shall be 4 or better (wet and dry) AATCC transference scale AATCC 165.
- I. Carpet is required to resist color transfer from wear for the life of the carpet. Carpet shall exhibit permanent colorfastness (wet or dry) for the lifetime of the installation as measured by AATCC Test method 8, minimum stain rating of 4 or better compared to AATCC color transference scale.
- J. The carpet shall exhibit permanent wetfastness for the lifetime of the installation as measured by AATCC Test Method 107, minimum shade change should be no less than International Gray Scale rating of 4 or better. water: 4 or better AATCC transference scale AATCC 107.
- K. Performance Characteristics: In addition, warrant the carpeting for a period of 10 years for the following:
 1. Appearance Retention Rating: Severe traffic, 3.5 minimum according to ASTM D 7330.
 2. Critical Radiant Flux Classification: Not less than 0.22 W/sq. cm according to NFPA 253.
 3. Delamination: Not less than 3.5 lbf/in. according to ASTM D 3936.

4. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
5. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
6. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 CARPET TILE

- A. Basis-of-Design Products: As indicated; refer to Finish Schedule on Drawings.
- B. Acceptable Manufacturers: Subject to compliance with requirements, provide product listed on Drawings by the following:
 1. Tarkett, or Architect approved equal by one of the following:
 - a. Interface, Inc.
 - b. Mohawk Carpet, LLC; The Mohawk Group.
- C. Primary Backing/Backcoating: Manufacturer's standard composite materials.
- D. Secondary Backing: Manufacturer's standard material.
- E. Size: As indicated on Drawings.
- F. Applied Treatments:
 1. Stain-Resistance Treatment: Manufacturer's standard permanent treatment meeting Performance Requirements above.
 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
- G. Sustainable Design Requirements:
 1. Sustainable Product Certification: Gold level certification according to ANSI/NSF 140.

2.3 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
 1. Adhesives shall have a VOC content of 50 g/L or less.
 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Metal Edge Strips: Extruded aluminum with finish as selected by Architect, of width shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
 - 3. Moisture Testing: Proceed with installation only after substrates pass testing according to carpet tile manufacturer's written recommendations, but not less stringent than the following so that each test area does not exceed 1000 sq. ft but perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas
 - a. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
 - 4. If tests exceed stated limits, apply approved moisture vapor emission control product complying with ASTM F-3010 in accordance with Section 090561.13 and allow to cure before installing carpet tile.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by carpet tile.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Non-vinyl wall covering.
 - 2. Textile wall covering.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals in accordance with Section 018113 "Sustainable Design Requirements" applicable to this Section may include the following:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, seams, and termination points.
- D. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified.
- E. Custom Graphics: For each custom graphic wall covering, provide drawings showing graphic elements and layout based on digital graphics provided by Architect.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates in accordance with test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 - 2. Fire-Growth Contribution: No flashover and heat and smoke release when tested in accordance with NFPA 265.

2.2 NON-VINYL WALL COVERINGS

- A. Basis-of-Design Product: As indicated; refer to Finish Schedule on Drawings.
- B. Description: Provide digitally printed custom PVC-free products in rolls from same production run and complying with the following:
 - 1. FS CCC-W-408D for Type II, Medium Duty.
- C. Total Weight: 18 oz/ lin yd, excluding coatings.
- D. Content: 10% Polyester, 40% Latex, 50% Cellulose
- E. Width: 50 inches.
- F. Backing: Cotton, Polyester Scrim fabric.
- G. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.
- H. Colors, Textures, and Patterns: Custom digital graphics. Graphics provided by Architect.

2.3 TEXTILE WALL COVERING

- A. Basis-of-Design Product: As indicated; refer to Finish Schedule on Drawings.
- B. Description: Provide wall coverings in rolls from same production run and that comply with the following:
 - 1. Fabric Type: Non-Woven
 - 2. FS CCC-W-408D for Type II, Medium Duty.
 - 3. Weight: 20 oz / lin yd
- C. Test Responses:
 - 1. Colorfastness to Wet and Dry Crocking: Complies with AATCC 8, Grade 3, minimum.
 - 2. Colorfastness to Light: Complies with AATCC 16.2 Test Option 1 or AATCC 16.3 Test Option 3, Class L4, minimum, at 40 hours.
 - 3. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.
- D. Width: 54 inches.
- E. Backing Fabric Weight: 1.8 oz/sq.yd
- F. Features:
 - 1. Stain-Resistant Coating: Manufacturer's standard.
 - 2. Strippable.
 - 3. Antimicrobial.
 - 4. Water-based inks.
- G. Colors, Textures, and Patterns: As indicated on Drawings.

2.4 ACCESSORIES

- A. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Primer/Sealer: Mildew resistant, complying with requirements in Section 099123 "Interior Painting" and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, and mildew.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
 1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
 2. Gypsum Board: Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
- D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.2 INSTALLATION OF WALL COVERING

- A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.
- B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.
- C. Install strips in same order as cut from roll.
 1. For solid-color, even-texture, or random-match wall coverings, reverse every other strip.
- D. Install wall covering without lifted or curling edges and without visible shrinkage.
- E. Match pattern 72 inches above the finish floor.
- F. Install seams vertical and plumb at least 6 inches from outside corners and 6 inches from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.
- G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.
- H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.
- I. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.
- J. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION

SECTION 097723 - FABRIC-WRAPPED PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes shop-fabricated, fabric-wrapped wall panels (AP-#).

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include fabric facing, panel edge, core material, and mounting indicated.
- B. Shop Drawings: For panel assembly and installation.
 - 1. Include plans, elevations, sections, and mounting devices and details.
 - 2. Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
 - 3. Include details at cutouts and penetrations for other work.
 - 4. Include direction of fabric weave and pattern matching.
- C. Samples for Verification: For the following products:
 - 1. Fabric: Full-width by approximately 36-inch- long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
 - 2. Panel Edge: 12-inch- long Sample(s) showing each edge profile, corner, and finish.
 - 3. Core Material: 12-inch- square Sample at corner.
 - 4. Assembled Panels: Approximately 36 by 36 inches, including joints and mounting methods.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of panel to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.4 QUALITY ASSURANCE

- A. Provide the following upon request:
 - 1. Product Certificates: For each type of panel.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with fabric and panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not install panels until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Air-Quality Limitations: Protect panels from exposure to airborne odors such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.

- C. Field Measurements: Verify panel locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace panels and components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Fabric sagging, distorting, or releasing from panel edge.
 - b. Warping of core.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Panels shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2.2 FABRIC-WRAPPED WALL PANELS

- A. Fabric-Wrapped Wall Panel, AP-3 and AP-4: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back edge border of core stretched over front face of edge-framed core and bonded or attached to edges and back of frame Insert description.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conwed.
 - b. Decoustics Limited; a Saint Gobain company.
 - c. Golterman & Sabo.
 - d. Panel Solutions, Inc.
 - e. Pinta Acoustic, Inc.
 - 2. Basis-of-Design Product: As indicated; refer to Finish Schedule on Drawings.
 - 3. Panel Shape: Flat.
 - 4. Mounting:
 - a. Back mounted with manufacturer's standard hook and loop strips, secured to substrate.
 - 5. Core: Manufacturer's standard.
 - 6. Edge Construction: Manufacturer's standard chemically hardened core with no frame.
 - 7. Edge Profile: Chamfered (beveled).
 - 8. Corner Detail in Elevation: Square with continuous edge profile indicated.
 - 9. Facing Material: As indicated on Drawings.
 - 10. Nominal Core Thickness: As indicated on Drawings.
 - 11. Panel Width: As indicated on Drawings.
 - 12. Panel Height: As indicated on Drawings.

2.3 MATERIALS

- A. Core Materials: Manufacturer's standard.
 - 1. Glass-Fiber Board: ASTM C612; of type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft., unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
- B. Facing Material : Fabric from same dye lot; color and pattern as indicated on Drawings.
 - 1. Applied Treatments: Stain resistance, flame-retardant.
- C. Mounting Devices: Concealed on back of panel, recommended by manufacturer to support weight of panel, and as follows:
 - 1. Hook-and-Loop Strips: Manufacturer's standard.

2.4 FABRICATION

- A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
- B. Edge Hardening: For glass-fiber board cores, chemically harden core edges and areas of core where mounting devices are attached.
- C. Facing Material: Apply fabric fully covering visible surfaces of panel; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
 - 1. Square Corners: Tailor corners.
 - 2. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.
- D. Dimensional Tolerances of Finished Panels: Plus or minus 1/16 inch for the following:
 - 1. Thickness.
 - 2. Edge straightness.
 - 3. Overall length and width.
 - 4. Squareness from corner to corner.
 - 5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fabric, fabricated panels, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting panel performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panels in locations indicated. Unless otherwise indicated, install panels with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

- B. Comply with manufacturer's written instructions for installation of panels using type of mounting devices indicated. Mount panels securely to supporting substrate.
- C. Align fabric pattern and grain with adjacent panels.

3.3 INSTALLATION TOLERANCES

- A. Variation from Plumb and Level: Plus or minus 1/16 inch in 48 inches, noncumulative.
- B. Variation of Joint Width: Not more than 1/16 inch wide from hairline in 48 inches, noncumulative.

3.4 CLEANING

- A. Clip loose threads; remove pills and extraneous materials.
- B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 097723

SECTION 098100 - ACOUSTICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Acoustical batt insulation in sound rated partitions.
 - 2. Acoustical batt insulation above suspended ceilings.
- B. Related Requirements:
 - 1. Section 079219 "Acoustical Joint Sealants" for joint sealants and electrical box putty pads used in sound-rated partitions and ceilings.

1.2 ACTION SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- B. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.
- C. LEED Submittals in accordance with Section 018113 "Sustainable Design Requirements" applicable to this Section may include the following:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

1.3 QUALITY ASSURANCE

- A. Provide the following upon request:
 - 1. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
 - 2. Manufacturer's Certificate: Certify that products meet or exceed specified requirements, and that products contain no asbestos.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project site in their original containers or packages or bundles bearing label clearly identifying manufacturer's name, brand, grade, UL listing, and other pertinent information.
- B. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

1.5 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Spread Index: 25 or less.
 2. Smoke Developed Index: 450 or less.

2.2 ACOUSTICAL INSULATION MATERIALS

- A. Batt Insulation - Walls: ASTM C 665, Type I; preformed batt; friction fit, for interior walls, conforming to the following:
1. Material: Inorganic Glass Fiber
 2. Fire Resistance:
 - a. Flame Spread Index: 25 or less, when tested in accordance with ASTM E 84.
 - b. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E 84.
 3. Acoustical Performance: 3.5 inch thickness, minimum.
 4. Facing: Unfaced.
 5. Manufacturers:
 - a. CertainTeed Corporation; CertaPro AcoustaTherm s: www.certainteed.com.
 - b. Johns Manville Corporation; Sound Control Batts: www.jm.com.
 - c. Knauf Insulation; QueitTherm QT: www.knaufinsulation.us.
 - d. Owens Corning Corp; EcoTouch Sound Attenuation Batts: www.owenscorning.com
- B. Batt Insulation - Ceilings: ASTM C 665, Type I; preformed batt; above lay-in suspended ceilings, conforming to the following:
1. Material: Inorganic Glass Fiber
 2. Fire Resistance:
 - a. Flame Spread Index: 25 or less, when tested in accordance with ASTM E 84.
 - b. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E 84.
 3. Thickness: 3.5 inches, as indicated.
 4. Size: 24 inches by 48 inches or 24 inch wide by roll length.
 5. Facing: Unfaced.
 6. Manufacturers:
 - a. CertainTeed Corporation; CertaPro AcoustaTherm: www.certainteed.com.
 - b. Johns Manville Corporation; Sound Control Batts: www.jm.com.
 - c. Knauf Insulation; QueitTherm QT: www.knaufinsulation.us.
 - d. Owens Corning Corp; EcoTouch Sonobatts Insulation: www.owenscorning.com

2.3 ACCESSORIES

- A. Insulation Fasteners: Impaling pins/clips of galvanized steel with washer retainer and clips, to be mechanically fastened to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place. Refer to Section 072100 "Thermal Insulation" for products as applicable.
- B. Wire Mesh: Galvanized steel, hexagonal wire mesh.

- C. Adhesives - General: Compatible with materials being adhered as instructed by insulation manufacturer for application; maximum VOC content of 50 g/L; GreenSeal GS-36 certified; in lieu of labeled product, independent test report showing compliance is acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation and adhesive.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.2 INSTALLATION OF INSULATION IN WALLS FOR SOUND ATTENUATION

- A. Install insulation in accordance with manufacturer's instructions.
- B. Install in interior wall and furring spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Friction fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation. Insulation shall be tight within spaces in partitions, around cut openings, behind and around electrical and mechanical items within or behind partitions and tight to items passing through partitions.
- E. For applications where the wall is not finished on both sides or insulation does not fill the cavity, supplementary support of the insulation such as wire or insulation impaling pins shall be provided to hold the insulation in place.
- F. Install blankets full height of wall.
 - 1. Where acoustical blankets are indicated for sound attenuation above ceilings separated by full-height partitions, extend acoustical blankets in wall cavity to roof/floor deck above. Install gypsum board on one or both sides of metal studs above ceiling as indicated.
 - 2. Where partition terminates at, or just above, ceiling, install acoustical blankets full height of wall in wall cavity and install blankets loose laid on ceiling as indicated below.
- G. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.

3.3 INSTALLATION OF INSULATION ABOVE CEILINGS FOR SOUND ATTENUATION

- A. Where acoustical blankets are indicated for sound attenuation above ceilings separated by full-height partitions, install blanket insulation over entire ceiling area in thicknesses indicated. Fit insulation tightly above ceiling, loose laid. Tightly fit around hangers, fixtures and other penetrating devices.
- B. Where acoustical blankets are indicated for sound attenuation above suspended ceilings with partition terminating below ceiling, fit insulation tightly above ceiling, loose laid. Refer to the suspended ceiling manufacturer's recommendations to ensure proper installation. Extend insulation 48 inches to both sides of partition above ceiling. Tightly fit around hangers, fixtures and other penetrating devices.
- C. For insulation mounted to side of gypsum board or other solid wall surface above ceiling, install adhesive-mounted impaling pins with metal caps at 24 inches vertically and at 4 inches from each side of blankets horizontally. Install blankets with 48 inch dimension running vertically on spikes, keeping blankets tight to exterior wall without crushing into each other.

3.4 PROTECTION

- A. Protect installed insulation from damage due to physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 098433 - SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:
 - 1. Sound-absorbing felt wall panels. (AP-#)

1.2 DEFINITIONS

- A. NRC: Noise Reduction Coefficient.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Environmental Product Declaration (EPD): For each product.
 - 3. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 - 4. Chain-of-Custody Qualification Data: For manufacturer and vendor.
 - 5. Product Data: For adhesives, indicating VOC content.
 - 6. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 7. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
 - 8. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.
- C. Samples for Verification: For the following products:
 - 1. Fabric: 8 inch square Sample.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.5 QUALITY ASSURANCE

- A. Provide the following upon request:
 - 1. Product Certificates: For each type of unit.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.
- C. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Acoustical performance.
 - b. Panel sagging, distorting, or warping.
 - 2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Verify wall materials comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 - 2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

2.2 SOUND-ABSORBING WALL UNITS

- A. Sound-Absorbing Wall Panel, AP-1 and AP-2: Manufacturer's standard solid felt panel construction.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Acoufelt
 - b. Autex
 - c. Slalom
 - 2. Basis-of-Design Product: Autex Cube, as indicated on Drawings.
 - a. Panel Shape: Flat.
 - b. Thickness: As indicated.

- c. Colors: As indicated; refer to Finish Schedule on Drawings.
- 3. Mounting: Manufacturer's recommended adhesive or double-sided tape, secured to substrate.
- 4. Acoustical Performance: Sound absorption NRC of not less than 020.

2.3 METAL EDGE STRIPS

- A. Metal Edge Strips: Metal edge protection of width shown, of height required to protect exposed edges of wall panels, and maximum available lengths to minimize running joints; finish and color as indicated.
 - 1. Basis of Design Manufacturers: Subject to compliance with requirements, provide basis-of-design shapes indicated as manufactured by the following:
 - a. Schluter Systems, LP, or comparable by one of the following:
 - 1) Blanke Corporation.
 - 2) Progress Profiles.
 - 2. Basis-of-Design Products: Style and sizes as indicated on Drawings.

2.4 FABRICATION

- A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with rigid edges to reinforce panel perimeter against warpage and damage.
- B. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:
 - 1. Thickness.
 - 2. Edge straightness.
 - 3. Overall length and width.
 - 4. Squareness from corner to corner.
 - 5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with manufacturer's written instructions for installation of units using type of mounting indicated. Mount units securely to supporting substrate.

3.3 INSTALLATION TOLERANCES

- A. Variation from Plumb and Level: Plus or minus 1/16 inch in 48 inches, noncumulative.
- B. Variation of Joint Width: Not more than 1/16-inch variation from hairline in 48 inches, noncumulative.

3.4 CLEANING

- A. Clip loose threads; remove pills and extraneous materials.
- B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on exterior substrates.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for shop primer used on exposed structural steel.

1.2 DEFINITIONS

- A. MPI Gloss Level 1 (Matte or Flat Finish): Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 5 (Semi-Gloss Finish): 35 to 70 units at 60 degrees, according to ASTM D 523.
- C. MPI Gloss Level 6 (Gloss Finish): 70 to 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 CLOSEOUT SUBMITTALS

- A. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.
- B. Submit two painted samples, 6 inches by 6 inches illustrating each color and system used on the Project.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 2 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to University.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain products from a single manufacturer.
- B. Manufacturers: Provide colors, gloss and finish indicated on Drawings either by manufacturer indicated, or equal matching color by one of the following to the acceptance of the Architect:
 1. Benjamin Moore & Co. (Basis-of-Design)
 2. Dunn Edwards.
 3. PPG Paints
 4. Sherwin-Williams Company (The).
- C. Provide products indicated in Exterior Painting Schedule at the end of this Section as manufactured by Benjamin Moore, or provide MPI-listed equivalent products from listed manufacturer's premium or professional product line.
 1. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- D. Colors: Colors indicated on Drawings are by Benjamin Moore. Color matching by other listed manufacturer is acceptable.

2.2 PAINT, GENERAL

- A. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
- C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- G. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Paint entire exposed surface of window frames and sashes.
 - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed to view:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: University may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Latex System **MPI EXT 3.1A:**

- a. Prime Coat: Primer, alkali resistant, water based, MPI #3.
 - 1) Benjamin Moore Ultra Spec Masonry Interior/Exterior 100% Acrylic Sealer #608
- b. Prime Coat, Latex: Exterior, matching topcoat.
- c. Intermediate Coat: Latex, exterior, matching topcoat.
- d. Flat Topcoat: Latex, exterior, flat (MPI Gloss Level 1), MPI #10.
 - 1) Benjamin Moore Aura Waterborne Exterior Flat #N629.
 - a) Film Thickness (per coat): 2.1 to 2.9 mils DFT (Not less than 4.6 mils wet)

B. Steel and Iron Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.1B:

- a. Shop Prime Coat: Shop primer specified in Section where substrate is specified.
- b. Prime Coat: If shop primer is not compatible with topcoats and additional primer is required over shop primer or for touch up of shop primer, provide additional coat of zinc-rich epoxy primer or DTM topcoat as recommended by topcoat manufacturer.
- c. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
- d. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
 - 1) Benjamin Moore Ultra Spec HP DTM Acrylic Semi-Gloss #HP29
 - a) Film Thickness (per coat): Not less than 2.3 mils DFT (Not less than 5.0 mils wet)

C. Galvanized-Metal Substrates (Bonderized, including flashings and sheet metal, unless otherwise indicated):

1. Water-Based Light Industrial Coating System MPI EXT 5.3K:

- a. Prep: Clean with oil and grease emulsifier as recommended by topcoat manufacturer.
 - 1) Benjamin Moore Oil & Grease Emulsifier Corotech V600
- b. First Coat: Light industrial coating, exterior, water based, matching topcoat.
- c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
 - 1) Benjamin Moore Ultra Spec HP DTM Acrylic Semi-Gloss #HP29
 - a) Film Thickness (per coat): Not less than 2.3 mils DFT (Not less than 5.0 mils wet)

- 2. For high-performance epoxy and urethane coatings on exterior steel railings, and exterior metallic-coated hollow metal doors and frames, refer to Section 099600 "High-Performance Coatings."

D. Galvanized Steel (Nonbonderized):

1. Water-Based Light Industrial Coating System: MPI EXT 5.3K (Modified)
 - a. Bonding Primer: Waterborne bonding primer over properly cleaned and prepared galvanized metal as instructed by primer manufacturer.
 - 1) Benjamin Moore Stix Waterborne Bonding Primer #SXA-110
 - b. First Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
 - 1) Benjamin Moore Ultra Spec HP DTM Acrylic Semi-Gloss #HP29
 - a) Film Thickness (per coat): Not less than 2.3 mils DFT (Not less than 5.0 mils wet)

E. Aluminum Substrates: Not prefinished aluminum.

1. Water-Based Light Industrial Coating System MPI EXT 5.6G:
 - a. Prime Coat: Primer, quick dry, for aluminum, as recommended by topcoat manufacturer to suit conditions.
 - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.

F. Fiberglass Substrates:

1. Latex System MPI EXT 6.7A:
 - a. Prime Coat: Primer, bonding, solvent based, MPI #69.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Topcoat: Latex, exterior, gloss (MPI Gloss Level 6), MPI #119.

G. Plastic Trim Fabrication Substrates:

1. Latex System MPI EXT 6.8A:
 - a. Prime Coat: Primer, bonding, solvent based, MPI #69.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Topcoat: Latex, exterior, gloss (MPI Gloss Level 6), MPI #119.

H. Exterior Canvas Substrates:

1. Latex System MPI EXT 10.1A:
 - a. Prime Coat: Latex, exterior, matching topcoat.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Topcoat: Latex, exterior, flat (MPI Gloss Level 1), MPI #10.

3.7 GRAFFITI RESISTANT COATINGS

- A. Performance Rate: Apply every 10 years.
- B. Preferred Manufacturers and Product lines: Professional Products of Kansas - Professional Water Sealant and Anti-Graffiti system; ProSoCo - Block Guard and Graffiti Control II; or Rain Guard - Vandguard Ten
- C. Use: All exterior concrete substrates below 96 inches above adjacent grade.

END OF SECTION

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete.
 - 2. Steel and iron.
 - 3. Galvanized metal.
 - 4. Fiberglass.
 - 5. Plastic.
 - 6. Gypsum board.
 - 7. Cotton or canvas insulation covering.
 - 8. ASJ insulation covering.
 - 9. Bituminous-coated surfaces.

- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for shop primer used on exposed structural steel.

1.2 DEFINITIONS

- A. MPI Gloss Level 1 (Matte or Flat Finish): Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 3 (Eggshell Finish): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 5 (Semi-Gloss Finish): 35 to 70 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.

- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.

- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 CLOSEOUT SUBMITTALS

- A. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

- B. Submit two painted samples, 6 inches by 6 inches illustrating each color and system used on the Project.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 2 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to University.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain products from a single manufacturer.
- B. Manufacturers: Provide colors, gloss and finish indicated on Drawings either by manufacturer indicated, or equal matching color by one of the following to the acceptance of the Architect:
 - 1. Benjamin Moore & Co. (Basis-of-Design)
 - 2. Dunn Edwards.
 - 3. PPG Paints.
 - 4. Sherwin-Williams Company (The).

- C. Provide products indicated in Interior Painting Schedule at the end of this Section as manufactured by Benjamin Moore, or provide MPI-listed equivalent products from listed manufacturer's premium or professional product line.
 - 1. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- D. Colors: Colors indicated on Drawings are by Benjamin Moore. Color matching by other listed manufacturer is acceptable.

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 50 g/L.
 - 3. Dry-Fog Coatings: 150 g/L.
 - 4. Primers, Sealers, and Undercoaters: 100 g/L.
 - 5. Rust-Preventive Coatings: 100 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Shellacs, Clear: 730 g/L.
 - 9. Shellacs, Pigmented: 550 g/L.
- C. Low-Emitting Materials: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean and prepare using methods recommended in writing by paint manufacturer, but not less than surface preparation requirements indicated where indicated in paint schedule below.
- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- H. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.
- I. Gypsum Board Substrates: Sand joint compound smooth. Remove dust from sanding procedures.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIRE-RATED AND SMOKE CONTAINMENT ASSEMBLIES

- A. Fire walls, fire barriers, fire partitions, smoke barriers and smoke partitions or any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling. Such identification shall:
 - 1. Be located in accessible concealed floor, floor-ceiling or attic spaces; and
 - 2. Be repeated at intervals not exceeding 30 feet measured horizontally along both sides of the wall or partition; and
 - 3. Include lettering not less than 3 inches in height, incorporating the suggested wording: " X HOUR FIRE AND/OR SMOKE BARRIER-PROTECT ALL OPENINGS" or other wording approved or required by AHJ (Authority Having Jurisdiction). Replace "X" with the appropriate designated hourly rating.
 - 4. Apply a minimum one-inch wide bright red horizontal line, both sides of wall, interrupted for approved text, at the required interval.
- B. Refer to the Life Safety Plan Drawings for locations of walls and applicable ratings.

3.5 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: University may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.6 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.7 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces: One of the following:
 - 1. High-Performance Architectural Latex System, MPI INT 3.1C:
 - a. Prime Coat: Primer, alkali resistant, water based, MPI #3.

- 1) Benjamin Moore Ultra Spec Masonry Interior/Exterior 100% Acrylic Sealer #608 or self-prime with topcoat as instructed by topcoat manufacturer
 - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
 - c. Topcoat: Latex, interior, high performance architectural, semigloss (MPI Gloss Level 5), MPI #141.
 - 1) Benjamin Moore Aura Waterborne Interior Paint & Primer #N528
 - a) Film Thickness (per coat): 1.4 to 1.5 mils DFT (Not less than 3.6 mils wet)
 2. Institutional Low-Odor/VOC Latex System, MPI INT 3.1M:
 - a. Prime Coat: Primer/sealer, interior, institutional low odor/VOC, as recommended by topcoat manufacturer.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.
 - 1) Benjamin Moore Ultra Spec 500, #T546
 - a) Film Thickness (per coat): 1.4 to 1.6 mils DFT (Not less than 3.6 mils wet)
- B. Steel Substrates:
 1. Institutional Low-Odor/VOC Latex System:
 - a. Surface Preparation: SSPC-SP 6, minimum.
 - b. Shop Prime Coat: Shop primer specified in Section where substrate is specified.
 - c. Prime Coat: If shop primer is not compatible with topcoats and additional primer is required over shop primer or for touch up of shop primer, provide additional coat of compatible anticorrosive primer as recommended by topcoat manufacturer.
 - d. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - e. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.
 - 1) Benjamin Moore Ultra Spec 500, #T546
 - a) Film Thickness (per coat): 1.4 to 1.6 mils DFT (Not less than 3.6 mils wet)
 2. Water-Based Dry-Fall System MPI INT 5.1C or MPI INT 5.1CC:
 - a. Shop Prime Coat: Shop primer specified in Section where substrate is specified.
 - b. Prime Coat: If shop primer is not compatible with topcoats and additional primer is required over shop primer or for touch up of shop primer, provide additional coat of compatible anticorrosive primer as recommended by topcoat manufacturer.
 - c. Topcoat: Dry fall, latex, flat, MPI #118.
 - 1) Benjamin Moore Latex Dry Fall #395
 - a) Film Thickness : Not less than 1.9 mils DFT, single coat (Not less than 4.6 mils wet)
 3. For high-performance epoxy and urethane coatings on interior steel railings, and interior hollow metal doors and frames, refer to Section 099600 "High-Performance Coatings."
- C. Galvanized-Metal Substrates (Bonderized):
 1. Institutional Low-Odor/VOC Latex System:
 - a. Prep: Clean with oil and grease emulsifier as recommended by topcoat manufacturer.
 - 1) Benjamin Moore Oil & Grease Emulsifier Corotech V600
 - b. First Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.

- 1) Benjamin Moore Ultra Spec 500, #T546
 - a) Film Thickness (per coat): 1.4 to 1.6 mils DFT (Not less than 3.6 mils wet)
- D. Gypsum Board Substrates:
 1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - 1) Benjamin Moore Eco Spec Interior Latex Primer #N372
 - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, eggshell (MPI Gloss Level 3), MPI #145.
 - 1) Benjamin Moore Ultra Spec 500, #T538
 - a) Film Thickness (percoat): 1.5 to 1.7 mils DFT (Not less than 3.6 mils wet)
 2. For high-performance epoxy coatings on drywall, refer to Section 099600 "High-Performance Coatings."
- E. Fiberglass Substrates:
 1. Latex System MPI INT 6.7A:
 - a. Prime Coat: Primer, bonding, water based, MPI #17.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.
- F. Plastic Substrates:
 1. Latex System MPI INT 6.8E:
 - a. Prime Coat: Primer, bonding, solvent based, MPI #69.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.
- G. Cotton or Canvas and ASJ Insulation-Covering Substrates: Including pipe and duct coverings.
 1. Latex System MPI INT 10.1A:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.
- H. Bituminous-Coated Substrates:
 1. Aluminum Paint System MPI INT 10.2C:
 - a. Prime Coat: Primer, rust inhibitive, water based, MPI #107.
 - b. Intermediate Coat: Aluminum paint, matching topcoat.
 - c. Topcoat: Aluminum paint, MPI #1.

END OF SECTION

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems.
- B. Related Requirements:
 - 1. Section 099113 "Exterior Painting" for general exterior field painting.
 - 2. Section 099123 "Interior Painting" for general interior field painting.

1.2 DEFINITIONS

- A. MPI Gloss Level 5 (Semi-Gloss Finish): 35 to 70 units at 60 degrees, according to ASTM D 523.
- B. MPI Gloss Level 6 (Gloss Finish): 70 to 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 CLOSEOUT SUBMITTALS

- A. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.
- B. Submit two painted samples, 6 inches by 6 inches illustrating each color and system used on the Project.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Coatings: 5 percent, but not less than 2 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain products from a single manufacturer.
- B. Manufacturers: Provide colors, gloss and finish indicated on Drawings matched by one of the following to the acceptance of the Architect:
 - 1. Benjamin Moore
 - 2. Carboline.
 - 3. Corotech.
 - 4. Sherwin-Williams Co.
 - 5. PPG Paints
 - 6. Tnemec Co. (The)
- C. Provide products indicated, or provide MPI-listed equivalent products from listed manufacturer's premium or professional product line.
 - 1. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
 - 3. Products shall be of same manufacturer for each coat in a coating system.
- B. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction. Refer, also, to Section 099123 "Interior Painting."
- C. Colors: As indicated on the Drawings or color matched by one of listed manufacturers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings. Clean with vinyl wash or emulsifier as instructed by manufacturer.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for coating and substrate indicated.
 - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

- C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: University may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
 - 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. General: The following products are provided to establish an intended level of quality. The inclusion of these products here does not preclude the use of other comparable products by any of the listed manufacturers as long as the colors match the basis-of-design colors indicated in the Finish Schedule on the Drawings to the acceptance of the Architect.
 - 1. Verify each coating system, primer, DFT, and substrate preparation requirements with coating manufacturer.
- B. Metallic-coated hollow metal doors and frames:
 - 1. Polyurethane, Pigmented
 - a. Pretreatment: Refer to "Preparation" article in this specification Section.
 - b. Factory Primer: Door manufacturer's standard factory-primer over galvanized steel.
 - 1) Verify compatibility of topcoats with factory-primer. If required, field apply one coat of epoxy primer as recommended by topcoat manufacturer.
 - c. Topcoats: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6).
 - 1) Product: Tnemec EnduraShield WB Series 1080
 - a) Film Thickness (per coat): 2.0 to 3.0 mils DFT; 2 coats over primer.
- C. Galvanized-Metal Substrates: Railings and similar galvanized steel items.
 - 1. Pigmented Polyurethane over Epoxy Primer System:

- a. Remove oil or soap film with detergent or emulsion cleaner as per SSPC SP-1 and galvanizing requirements, then use a phosphatizing conversion coating or vinyl wash indicated. Alternately, power tool clean to uniformly abrade the surface or lightly abrasive blast with a fine abrasive to produce a uniform and dense anchor profile of 1.0 – 2.0 mils in accordance with SSPC SP-16 and paint manufacturer's recommendations.
- b. Galvanizing that has had at least 12 months of exterior weathering may be coated after power washing to remove all contaminants and white rust. Galvanized surfaces that have been passivated with a chromate treatment shall be abrasive blasted. Coatings may not adhere to chromate sealed galvanizing if the chromates are not completely removed.
- c. Vinyl Wash or Emulsifier: Vinyl butyral/phosphoric acid primer wash coat or oil and grease emulsifier as recommended by finish coat manufacturer to suit condition.
- d. Prime Coat: Primer, epoxy, anti-corrosive, for galvanized metal MPI #101
- e. Topcoats: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6).
 - 1) Product: Tnemec EnduraShield WB Series 1080
 - a) Film Thickness (per coat): 2.0 to 3.0 mils DFT; 2 coats over primer.

3.7 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. General: Verify each coating system, primer, DFT, and substrate preparation requirements with coating manufacturer.
- B. Steel Substrates; Steel railings and handrails, exposed metal stairs:
 - 1. Pigmented Polyurethane over Epoxy Primer System:
 - a. Pretreatment: Refer to "Preparation" article in this specification Section.
 - b. Factory Primer: Door manufacturer's standard factory-primer over steel.
 - 1) Verify compatibility of topcoats with factory-primer. If required, field apply one coat of the following epoxy primer as recommended by topcoat manufacturer.
 - c. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
 - 1) Benjamin Moore HP Epoxy Mastic, #HP4600
 - a) Film Thickness: Not less than 4.6 mils DFT, single coat. (Not less than 5.8 mils wet)
 - d. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
 - e. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.
 - 1) Benjamin Moore Aliphatic Urethane, #HP5000
 - a) Film Thickness (per coat): 2.3 to 3.3 mils DFT (Not less than 3.2 mils wet)
- C. Steel Substrates; Factory-primed interior hollow metal doors and frames:
 - 1. Pigmented Polyurethane over Epoxy Primer System:
 - a. Prep: Surfaces shall be clean, dry and free of all grease, dirt, dust, oil and wax. Remove all remaining shop primer, rust and mill scale via Hand Tool Cleaning (SSPC-SP 2) or Power Tool cleaning (SSPC-SP 3). Fill holes and cracks and sand smooth. Glossy surfaces must be fully deglossed. Moderate to heavily rusted areas must be thoroughly prepared and active rust shall be properly removed. Clean all surfaces using manufacturer's oil and grease emulsifier as instructed by primer and topcoat manufacturer.
 - b. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
 - 1) Benjamin Moore HP Epoxy Mastic, #HP4600
 - a) Film Thickness: Not less than 4.6 mils DFT, single coat. (Not less than 5.8 mils wet)
 - c. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
 - d. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

- 1) Benjamin Moore Aliphatic Urethane, #HP5000
 - a) Film Thickness (per coat): 2.3 to 3.3 mils DFT (Not less than 3.2 mils wet)

D. Gypsum Board Substrates:

1. On Walls and Ceilings, where indicated: Epoxy, eggshell:
 - a. Prime Coat/PVA Sealer: 100% acrylic drywall primer/sealer, MPI #149 - Verify compatibility with drywall joint compound; test to ensure bond. Clean drywall of all sanding dust prior to primer application according to primer manufacturer's instructions and limitations.
 - 1) Benjamin Moore EcoSpec Interior Latex Primer, #N372.
 - a) Film Thickness: Not less than 1.2 mils DFT, single coat. (Not less than 4.0 mils wet)
 - b. Intermediate Coat: Waterborne epoxy, matching topcoat
 - c. Topcoat: Waterborne epoxy, eggshell (MPI Gloss Level 3-4), MPI #151
 - 1) Benjamin Moore Pre-Catalyzed Waterborne Epoxy, #V342
 - a) Film Thickness (per coat): 1.5 to 1.7 mils DFT (Not less than 4 mils wet)

END OF SECTION

SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Fixed markerboards
 2. Sliding markerboards.
 3. Floor-to-ceiling writable surfaces.
 4. Tackable linoleum specialty bulletin boards.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
 2. Include electrical characteristics for motorized units.
- B. Shop Drawings: For each type of visual display units.
1. Include plans, elevations, sections, details, and attachment to other work.
 2. Show locations of panel joints. Show locations of field-assembled joints for factory-fabricated units too large to ship in one piece.
 3. Show locations and layout of special-purpose graphics.
 4. Include sections of typical trim members.
 5. Include wiring diagrams for power and control wiring.
- C. Samples for Verification: For each type of visual display unit indicated.
1. Visual Display Panel: Not less than 8-1/2 by 11 inches, with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
 2. Trim: 6-inch- long sections of each trim profile.
 3. Display Rail: 6-inch- long section of each type.
- D. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For visual display units to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Provide the following upon request:
1. Qualification Data: For qualified Installer.
 2. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of tackboards.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.
 - 1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.7 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 50 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VISUAL DISPLAY BOARD ASSEMBLY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Best-Rite Manufacturing; a brand division of MooreCo, Inc.
 - 2. Claridge Products and Equipment, Inc.
 - 3. Platinum Visual Systems; a division of ABC School Equipment, Inc.
- B. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated magnetic markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with low-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
 - 1. Face Sheet Thickness: 28 gauge, uncoated base metal thickness.
 - 2. Hardboard Core: 1/4 inch thick; with 0.005-inch-thick, aluminum foil backing.
 - 3. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.
 - 4. Color: White.
- C. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; standard size and shape.
- D. Markertray: Manufacturer's standard; continuous.
- E. Display Rail: Manufacturer's standard, extruded-aluminum display rail with plastic-impregnated-cork insert, end stops, and continuous paper holder, designed to hold accessories.
 - 1. Size: 2 inches high by full length of visual display unit.
- F. Paper Holder Display Rail: Extruded aluminum; designed to hold paper by clamping action.

2.2 SLIDING VISUAL DISPLAY UNITS

- A. Vertical-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed rear visual display panel, and aluminum-framed vertical-sliding panels. Provide panels that operate smoothly without vibration or chatter.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Best-Rite Manufacturing; a brand division of MooreCo, Inc.
 - b. Claridge Products and Equipment, Inc.
 - c. Platinum Visual Systems; a division of ABC School Equipment, Inc.
2. Type: Tubular frame on top and two sides, with sides extending to floor; with kick panel to conceal sliding panels. Design unit to support panels independently of wall.
3. Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide sliding panels, each equal to not less than one-half of overall height of unit.
 - a. Quantity of Panels: As indicated.
4. Hardware: Manufacturer's standard, neoprene ball-bearing end rollers, four on each side of each sliding panel. Counterbalance each sliding panel with counterweights supported by steel aircraft cable over ball-bearing sheaves; with removable cover plate for access to counterweights. Provide rubber bumpers at top and bottom for each sliding panel.
5. Overall Width: As indicated on Drawings.
6. Overall Height: As indicated on Drawings.

B. Panels and Accessories:

1. Sliding Markerboard Panel: Porcelain-enamel-faced markerboard panel on manufacturer's standard core designed to be rigid and to resist warpage.
 - a. Color: As selected by Architect from full range of industry colors
2. Fixed Rear Markerboard Panel: Porcelain-enamel-faced markerboard panel on core indicated.
 - a. Color: As selected by Architect from full range of industry colors.
3. Accessories: Chalktray.
4. Display Rail: Manufacturer's standard, extruded-aluminum display rail with plastic-impregnated-cork insert, end stops, and continuous paper holder, designed to hold accessories.
 - a. Size: 1 inch high by full length of visual display unit.
5. Aluminum Trim: Factory- or field- applied; in manufacturer's standard size and profile; with clear anodic finish.

2.3 FLOOR-TO-CEILING VISUAL DISPLAY ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Claridge Products and Equipment, Inc.
 2. Platinum Visual Systems; a division of ABC School Equipment, Inc.
- B. Basis-of-Design Product: Platinum Visual Writanium Porcelain Markerwall from manufacturer's FCS Series
- C. Floor-to-Ceiling Markerwall Panel Assemblies: Consisting of markerboard panels with porcelain-enamel facing on core indicated; fabricated for floor-to-ceiling assemblies.
1. Width: As indicated on Drawings.
 2. Height: Full height of wall.
 3. Joints: Butt joint factory-fired edges vertically to form smooth transition from panel to panel
 4. Splines: Panels to be factory-milled to accept aluminum stabilizing spline at each joint
 5. Color: As selected from manufacturer's standard color
- D. Porcelain Markerwall Materials:
1. Steel Face Sheets: Writing surface will be 28 gauge steel face with porcelain enamel finish fused to the steel sheet using a continuous coil process

2. Core Material: 7/16 inch thick particleboard
3. Backing Material: 0.005 inch aluminum backing sheet
4. Metal Trim and Accessories: 6063 aluminum alloy with a T5 temper with clear anodized finish
 - a. Frame: Channel frame with 3/4 inch face. No exposed fasteners permitted
 - b. Chalktray: Standard solid magnetic chalktray with ribbed section and smoothly curved ends
5. Adhesive: As recommended by manufacturer for project conditions

2.4 LINOLEUM SHEET TACKABLE SURFACES - TP-1 AND TP-2

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "Bulletin Board" pinboard linoleum as manufactured by Forbo Flooring Systems, or Architect approved equal.
 1. Thickness: 1/4 inch
 2. Size: As indicated.
 3. Color: As indicated on Drawings.
 4. Mounting: As indicated on Drawings.

2.5 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. Plastic-Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout with surface-burning characteristics indicated.
- C. Hardboard: ANSI A135.4, tempered.
- D. Extruded Aluminum: ASTM B 221, Alloy 6063.
- E. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
 1. Verify adhesives have a VOC content of 50 g/L or less.
 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Section 099123 "Interior Painting" and recommended in writing by visual display unit manufacturer for intended substrate.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

- A. General: As selected by Architect from the following:

1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation and backing for visual display units.
- C. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.
- D. Prime wall surfaces indicated to receive visual display units and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.

3.3 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
 1. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.
- C. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 16 inches o.c. Secure tops and bottoms of boards to walls.
- D. Visual Display Board Assembly Mounting Heights: Install visual display units at mounting heights indicated on Drawings, or if not indicated, at heights indicated below.
 1. Mounting Height: 36 inches above finished floor to top of chalktray.
- E. Sliding Visual Display Units: Install units at mounting heights indicated. Attach to wall framing with fasteners at not more than 16 inches o.c.
 1. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

- F. Floor-to-Ceiling Markerboard Panels: Attach panels to wall surface with egg-size adhesive gobs at 16 inches o.c., horizontally and vertically.
 - 1. Join adjacent panels with concealed steel splines for smooth alignment.

3.4 CLEANING AND PROTECTION

- A. Clean visual display units according to manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

END OF SECTION

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Illuminated, fabricated channel dimensional characters.

1.2 DEFINITIONS

- A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

- A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
 - 4. Show locations of electrical service connections.
 - 5. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Dimensional Characters: Full-size Sample of each type of dimensional character.
 - 2. Exposed Accessories: Full-size size Sample of each accessory type.
 - 3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.
- E. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Provide the following upon request:
 - 1. Qualification Data: For Installer.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Separation or delamination of sheet materials and components.
 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
1. Uniform Wind Load: As indicated on Drawings.
 2. Concentrated Horizontal Load: As indicated on Drawings.
 3. Other Design Load: As indicated on Drawings
 4. Uniform and concentrated loads need not be assumed to act concurrently.
- B. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 DIMENSIONAL CHARACTERS

- A. Fabricated Channel Characters: Metal face and side returns, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ASI Sign Systems, Inc., or comparable by one of the following:
 - 1) Arrow Sign Company
 - 2) Ellis & Ellis Sign Systems, Inc.
 - 3) Martinelli Environmental Graphics
 - 4) Priority Graphics
 - 5) WeidnerCA
 2. Illuminated Characters: Backlight character construction with LED lighting, including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.
 - a. Power: 120 V, 60 Hz, 1 phase, 15 A.
 - b. Weeps: Provide weep holes to drain water at lowest part of exterior characters. Equip weeps with permanent baffles to block light leakage without inhibiting drainage.

3. Character Material: Sheet or plate aluminum.
4. Material Thickness: Manufacturer's standard for size and design of character.
5. Character Height: As indicated on Drawings.
6. Character Depth: As indicated on Drawings.
7. Finishes:
 - a. Integral Metal Finish: As selected by Architect from full range of industry finishes.
8. Mounting: Manufacturer's standard for size and design of character as indicated on Drawings.
9. Typeface: Campus standard.

2.3 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.
- B. Aluminum Sheet and Plate: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- C. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- D. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 - b. Fastener Heads: For nonstructural connections, use flathead oval countersunk Insert shape screws and bolts with tamper-resistant Allen-head spanner-head one-way-head Insert slot design slots unless otherwise indicated.
 4. Sign Mounting Fasteners: as indicated or as provided as standard to suit conditions.
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
 - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
 - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.
- B. Adhesive: As recommended by sign manufacturer.
 1. Adhesives shall have a VOC content of 70 g/L or less.
 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
 - 7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
 - 1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match sign-background color unless otherwise indicated.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that electrical service is correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

- B. Mounting Methods:
 - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
 - 2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
 - 3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
 - 4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

- B. Remove temporary protective coverings and strippable films as signs are installed.

- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION

SECTION 101423 - PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Room-identification signs.
 - 2. Directional signage.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Room-Identification and Directional Signs: Full-size Sample.
- D. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Provide the following upon request:
 - 1. Qualification Data: For Installer.
 - 2. Wiring Diagrams: Include diagrams for power, signal, and control wiring.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify locations of anchorage devices embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: Insert temperature change.
- B. Accessibility Standard: Comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design as amended by CBC Title 24 Section 11B-703 for signs.

2.2 SIGNS

- A. General: Signs shall conform to CBC Section 11B-216 and as otherwise indicated.
- B. Room-Identification, Regulatory, Emergency, and Directional and Wayfinding Signs: Signs with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 1. Basis-of-Design Product: Match Campus standard and as indicated on Drawings.
 2. Mounting: Surface mounted to wall with two-face tape or hook-and-loop tape.
 3. Surface Finish and Applied Graphics: Match existing.
 4. Text and Typeface: Match existing with accessible raised characters and Braille. Finish raised characters to contrast with background color, and finish Braille to match background color.
 5. Flatness Tolerance: Sign panel shall remain flat or uniformly curved under installed conditions as indicated and within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner.

2.3 ACCESSORIES

- A. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.
- B. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.

2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 4. Internally brace signs for stability and for securing fasteners.
 5. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into panel surface indicated to produce precisely formed copy, incised to uniform depth.
 1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.

2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
 3. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
 4. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.
- C. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.
- D. Subsurface-Engraved Graphics: Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that anchor inserts are correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as indicated and according to accessibility standard.
- C. Mounting Methods:

1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
 2. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips 0.250 inch away from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; push and rub well to fully engage tape adhesive to substrate.
 3. Shim-Plate Mounting: Provide 1/8-inch- thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using one of the methods specified above.
- D. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION

SECTION 102113.17 - PHENOLIC-CORE TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Phenolic-core toilet compartments.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for sheet metal backing in-wall.
 - 2. Section 102800 "Toilet Accessories" for accessories mounted on toilet compartments.

1.2 COORDINATION

- A. Coordinate requirements for reinforcing, and other supports concealed within wall to ensure that toilet compartments can be supported and installed as indicated.

1.3 ACTION SUBMITTALS

- A. Product Data: Phenolic-core toilet compartments.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachment details.
 - 2. Show locations of cutouts for compartment-mounted toilet accessories.
 - 3. Show locations of centerlines of toilet fixtures.
 - 4. Show locations of floor drains.
- C. Samples for Verification: Actual sample of finished products for each type of toilet compartment, hardware, and accessory.
 - 1. Size: Manufacturer's standard size.
- D. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For toilet compartments.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 75 or less.
 2. Smoke-Developed Index: 450 or less.
- B. Structural Performance: Where grab bars are mounted on toilet compartments, design panels to comply with the following requirements:
1. Panels are able to withstand a concentrated load on grab bar of at least 250 lbf applied at any direction and at any point, without deformation of panel.
- C. Regulatory Requirements: Comply with applicable provisions in CBC Title 24 Chapter 11B for toilet compartments designated as accessible.

2.2 PHENOLIC-CORE TOILET COMPARTMENTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ASI Global Partitions.
 2. Bobrick Washroom Equipment, Inc.
 3. Bradley Corporation.
- B. Basis-of-Design Product: Bobrick Sierra Series, Model 2092G.67P
- C. Toilet-Enclosure Style: Overhead braced.
- D. Urinal-Screen Style: Wall hung.
- E. Door, Panel, and Pilaster Construction: Solid phenolic-core material with melamine facing on both sides fused to substrate during manufacture (not separately laminated), and with eased and polished edges. Provide minimum 3/4-inch- thick doors and pilasters and minimum 1/2-inch- thick panels. Provide with no-sightline system consisting of door and pilaster lapped edges on strike side of door and door and pilaster lapped edges on hinge side of door (unless continuous hinge is used).
- F. Urinal-Screen Construction: Matching panel construction.
- G. Pilaster Shoes: Formed from stainless steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.
- H. Brackets (Fittings):
1. Full-Height (Continuous) Type: Manufacturer's standard design, stainless steel.
- I. Phenolic Compartment Finish: One color in each room.
1. Through-Color Phenolic: Manufacturer's standard solid through-color.
 - a. Color: As selected by Architect from manufacturer's full range.

2.3 HARDWARE AND ACCESSORIES

- A. Door Hardware and Accessories, Heavy Duty: Manufacturer's heavy-duty institutional operating hardware and accessories.
1. Hinges: Manufacturer's minimum 0.062-inch- thick, stainless steel surface-mounted, paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door. Mount with through bolts.
 2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at toilet enclosures designated as accessible. Mount with through bolts.

3. Coat Hook: Manufacturer's heavy-duty, combination cast stainless steel hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories. Mount with through bolts.
 4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast stainless steel bumper at outswinging doors. Mount with through bolts.
 5. Door Pull: Manufacturer's heavy-duty, cast stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at toilet enclosures designated as accessible. Mount with through bolts.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 MATERIALS

- A. Aluminum Extrusions: ASTM B221.
- B. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- C. Stainless Steel Castings: ASTM A743/A743M.

2.5 FABRICATION

- A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, inswinging doors for standard toilet enclosures and 36-inch- wide, outswinging doors with a minimum 32-inch- wide, clear opening for toilet enclosures designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
1. Maximum Clearances:
 - a. Pilasters and Panels or Screens: 1/2 inch.

- b. Panels or Screens and Walls: 1 inch.
- 2. Full-Height (Continuous) Brackets: Secure panels or screens to walls and to pilasters with full-height brackets.
 - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.17

SECTION 102600 - WALL PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic corner guards (CG-#)
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for metal armor, kick, mop, and push plates.

1.2 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, impact strength, fire-test-response characteristics, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.
- B. Sustainable Design Submittals:
 - 1. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, joint locations and attachments to other work.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Corner Guards and Wall Base: 12 inches long. Include examples of joinery, corners, end caps, and field splices.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.
 - 1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of impact-resistant wall protection units from single source from single manufacturer.
- B. Surface-Burning Characteristics: Provide impact-resistant, plastic wall protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another qualified testing agency.
- C. Provide the following upon request:
 - 1. Material Certificates: For each impact-resistant plastic material, from manufacturer.
 - 2. Material Test Reports: For each impact-resistant plastic material.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
 - 2. Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.
 - a. Store corner-guard covers in a vertical position.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F for not less than 72 hours before beginning installation and for the remainder of the construction period.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Deterioration of plastic and other materials beyond normal use.
 - 2. Warranty Period: Manufacturer's standard but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. PVC-Free Plastic: An engineered PETG or proprietary blend of high-performance materials that is free of PVC, phthalates, persistent bioaccumulative toxins (PBT) and bisphenol A (BPA) with UL Class A/1 fire rating; extruded and sheet material, thickness as indicated.
 - 1. Available Products: Subject to compliance with requirements, provide one of the following:
 - a. Construction Specialties, Inc. (C/S Group): Acrovyn 4000
 - b. IPC Door and Wall Protection Systems (a division of InPro Corporation); G2 BioBlend.
 - c. Korogard Wall Protection Systems (a division of RJF International Corporation); Korogard ETS.
- B. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated, but with not less than strength and durability properties specified in ASTM B 221 for Alloy 6063-T5.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M.
- D. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- E. Two-Sided Adhesive Tape: As recommended by protection product manufacturer.

- F. Adhesive: As recommended by protection product manufacturer.
 - 1. Verify adhesives have a VOC content of 70 g/L or less.
 - 2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 CORNER GUARDS

- A. Surface-Mounted, Resilient, Plastic Corner Guards (CG-1 and CG-2): Assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
 - 1. Cover: Extruded, rigid PVC-free plastic, minimum 0.078-inch wall thickness; as follows:
 - a. Profile: Nominal; minimal radius.
 - 1) CG-1: 3/4 inch wings
 - 2) CG-2: 1-1/2 inch wings
 - b. Height: 4 feet and full height to ceiling where indicated.
 - c. Color and Texture: As indicated.
 - 2. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover.
- B. Surface-Mounted, Metal Corner Guards (CG-3): Fabricated from one-piece, formed stainless steel with formed edges; with 90- or 135-degree turn to match wall condition.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Balco, Inc.
 - b. Construction Specialties, Inc.
 - c. IPC Door and Wall Protection Systems; Division of InPro Corporation.
 - d. Korogard Wall Protection Systems; a division of RJF International Corporation.
 - e. WallGuard.com.
 - 2. Material: Stainless steel, Type 304.
 - a. Thickness: Minimum 0.0625 inch.
 - b. Finish: Directional satin, No. 4.
 - 3. Wing Size: Nominal 3-1/2 by 3-1/2 inches.
 - 4. Corner Radius: Approximately 1/8 inch.
 - 5. Mounting: Double-faced, adhesive foam tape or adhesive.

2.3 END-WALL GUARDS

- A. Surface-Mounted, Resilient, Plastic End-Wall Guard: Assembly consisting of snap-on plastic cover installed over continuous retainer or continuous retainer at each corner, with end of wall covered by semirigid, impact-resistant sheet wall covering to suit conditions; including mounting hardware.
 - 1. Match corner guards.
- B. Surface-Mounted, Metal, End-Wall Guards: Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.
 - 1. Match corner guards.

2.4 FABRICATION

- A. Fabricate impact-resistant wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.

- B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.5 METAL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 3. Run grain of directional finishes with long dimension of each piece.
 - 4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of work.
- B. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For impact-resistant wall protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
 - 1. Install impact-resistant wall protection units in locations and at mounting heights indicated on Drawings.
 - a. Corner Guards: Mount bottom above wall base.
 - 2. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
 - a. Provide anchoring devices to withstand imposed loads.

- b. Where splices occur in horizontal runs of more than 20 feet, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches.
- c. Adjust end caps as required to ensure tight seams.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION

SECTION 102800 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Washroom accessories.
 - 2. Custodial accessories.
 - 3. Underlavatory guards.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for sheet metal reinforcing for backing in metal stud partitions.

1.2 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify accessories using designations indicated.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.5 WARRANTY

- A. Manufacturer's Special Warranty for Framed Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Standard Requirements: Standard finish for washroom accessories shall be brushed stainless steel, unless otherwise indicated. Provide universally keyed locks and standard mounting fasteners. Provide minimum of six keys to Owner's representative.

2.2 TOILET AND CUSTODIAL ACCESSORIES

- A. Source Limitations: Obtain toilet accessories from single source from single manufacturer, unless otherwise indicated.
 - 1. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated on Drawings or comparable product by one of the following:
 - a. American Specialties, Inc.; ASI Group.
 - b. Bobrick Washroom Equipment, Inc.
 - c. Bradley Corporation.
- B. Basis-of-Design Products: Refer to Toilet Accessories Schedule on Drawings.

2.3 UNDERLAVATORY GUARDS

- A. Underlavatory Guard:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Plumberex Specialty Products, Inc.
 - b. Truebro by IPS Corporation.
 - 2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
 - a. Basis-of-Design Products: Plumberex Pro-Extreme
 - 3. Material and Finish: Antimicrobial, molded plastic, white.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturer's written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire-protection cabinets for the following:
 - a. Portable fire extinguishers.
- B. Related Requirements:
 - 1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets.

1.2 PREINSTALLATION CONFERENCE

- A. Preinstallation Conference: Conduct conference at Project site. Include Campus fire marshall.
 - 1. Review methods and procedures related to fire-protection cabinets, including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing mounting method and relationships of box and trim to surrounding construction.
- B. Shop Drawings: For fire-protection cabinets.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For each type of exposed finish required.
- D. Samples for Verification: For each type of exposed finish required, prepared on samples 6 by 6 inches square.
- E. Product Schedule: For fire-protection cabinets. Indicate mounting method and rating of wall. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.3 FIRE-PROTECTION CABINET

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
 - 2. Larsen's Manufacturing Company.
 - 3. Potter Roemer LLC; a Division of Morris Group International.
- B. Cabinet Construction: Nonrated and rated as indicated.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch-thick cold-rolled steel sheet lined with minimum 5/8-inch-thick fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Cold-rolled steel sheet
 - 1. Shelf: Same metal and finish as cabinet.
- D. Recessed Cabinet:
 - 1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
- E. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
 - 1. Square-Edge Trim: 1-1/4- to 1-1/2-inch (32- to 38-mm) backbend depth.
- F. Cabinet Trim Material: Same material and finish as door.
- G. Door Material: Steel sheet
- H. Door Style: Vertical duo panel with frame.
- I. Door Glazing: Tempered float glass (clear)
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide recessed door pull and friction safety latch.
 - 2. Provide continuous hinge, of same material and finish as trim, concealed hinge pivot hinge manufacturer's standard hinge, permitting door to open 180 degrees.
- K. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle
3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. .
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet door cabinet glazing location indicated on Drawings.
 - 2) Application Process: Manufacturer's standard.
 - 3) Lettering Color: Black.
 - 4) Orientation: Vertical

L. Materials:

1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - a. Finish: Factory primed for field painting Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
 - b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - c. Color: White.
2. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.4 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
 2. Miter corners and grind smooth.
 3. Provide factory-drilled mounting holes.
 4. Prepare for hardware installation in factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Fabricate door frames of one-piece construction with edges flanged.
 3. Miter and weld perimeter door frames and grind smooth.

- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION OF FIRE-PROTECTION CABINETS

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
 - 2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
 - 3. Fire-Rated Cabinets:
 - a. Install cabinet with not more than 1/16-inch tolerance between pipe OD and knockout OD. Center pipe within knockout.
 - b. Seal through penetrations with firestopping sealant as specified in Section 078413 "Penetration Firestopping."

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
- B. Related Requirements:
 - 1. Section 104413 "Fire Protection Cabinets."

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site in conjunction with preinstallation meeting regarding fire protection cabinets. Include representatives of the Owner, Architect and governing fire authority.
 - 1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. California Compliance: Comply with California Code of Regulations, Title 19, Division 1, Chapter 3 - Portable Fire Extinguishers
- B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet mounting bracket indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Activar Construction Products Group, Inc. - JL Industries.
 - b. Badger Fire Protection.
 - c. Guardian Fire Equipment, Inc.
 - d. Larsens Manufacturing Company.
 - e. Pyro-Chem; brand of Johnson Controls International plc, Building Solutions North America.
 - f. Strike First Corporation of America (The).
 - 2. Handles and Levers: Manufacturer's standard.
 - 3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 1A:60-B:C, 10-lb 9.1-kg nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container; or
- C. Multipurpose Dry-Chemical Type in Aluminum Container: UL-rated A:60-B:C, 10-lb 9.1-kg nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red black baked-enamel finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 104416

SECTION 105123 - PLASTIC-LAMINATE-CLAD LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Plastic-laminate-clad wood lockers.

1.2 ACTION SUBMITTALS

- A. Product Data Submittals: For each product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker.
- B. Shop Drawings: For plastic-laminate-clad wood lockers.
1. Include plans, elevations, sections, and attachment details.
 2. Show details full size.
 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 4. Show locations and sizes of cutouts and holes for items installed in lockers.
 5. Show locker fillers, trim, base, sloping tops, and accessories.
 6. Show locker identification system and numbering sequence.
- C. Samples for Verification: For the following products:
1. Plastic-laminate-clad panels, not less than 8 by 10 inches, for each type, color, pattern, and surface finish.
 2. Thermally fused laminate-overlay-surfaced panels, not less than 8 by 10 inches, for each type, color, pattern, and surface finish.
 3. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- C. Provide the following upon request:
1. Qualification Data: For Installer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver lockers until painting and similar operations that could damage lockers have been completed in installation areas. If lockers must be stored in other-than-installation areas, store only in areas where environmental conditions are the same as those in final installation location, and comply with requirements specified in "Field Conditions" Article.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install lockers until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Field Measurements: Where lockers are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.
 - 1. Locate concealed framing, blocking, and reinforcements that support lockers by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where lockers are indicated to fit to other construction, establish dimensions for areas where lockers are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that lockers can be supported and installed as indicated.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of lockers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of locks or hardware.
 - c. Deterioration of wood, finishes, and other materials beyond normal use.
 - 2. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in CBC Title 24 Chapter 11B

2.2 PLASTIC-LAMINATE-CLAD WOOD LOCKERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Classic Woodworking, LLC.
 - 2. Club Resource Group.
 - 3. Famous Lockers.
 - 4. Hollman, Inc.
 - 5. Ideal Products, Inc.
 - 6. Legacy Lockers.
 - 7. List Industries Inc.
 - 8. Treeforms.
- B. Construction Style: Flush overlay.
- C. Final Assembly: Manufacturer's standard factory assembly.

- D. Locker Body: Fabricated from particleboard -core panels covered on both sides with thermally fused laminate overlay.
 - 1. Side Panels: Manufacturer's standard 3/4 or 5/8 inch thick.
 - 2. Back Panel: Manufacturer's standard 1/2 or 3/8 inch thick.
 - 3. Top Panel: Manufacturer's standard 3/4 or 5/8 inch thick.
 - 4. Bottom Panel: Manufacturer's standard 3/4 or 5/8 inch thick.
 - 5. Exposed Panel Edges: 1-mm-thick PVC.
- E. Plastic-Laminate-Clad Wood Doors: High-pressure decorative laminate, Grade VGS, over both sides of particleboard or medium-density-fiberboard core.
 - 1. Thickness: Manufacturer's standard 3/4 or 5/8 inch thick.
 - 2. Panel Edges: 1-mm-thick PVC.
- F. End Panels: Match style, material, construction, and finish of plastic-laminate-clad wood doors.
- G. Shelves: Fabricated from particleboard -core panels covered on both sides with thermally fused laminate overlay; fixed.
 - 1. Thickness: 5/8 inch.
 - 2. Exposed Edges: 3-mm-thick PVC.
- H. Corners and Filler Panels: 3/4-inch- thick panels. Match style, material, construction, and finish of plastic-laminate-clad wood doors.
- I. Continuous Finish Base: Plastic-laminate-clad, 3/4-inch- thick panel that matches door faces; fabricated in lengths as long as practical to enclose base and base ends of lockers.
- J. Continuously Sloping Tops: Plastic-laminate-clad, 3/4-inch- thick panel that matches door faces for installation over lockers with separate flat tops. Fabricate tops in lengths as long as practical, without visible fasteners at splice locations. Provide fasteners, supports, and closures, as follows:
 - 1. Closures: Hipped-end type.
 - 2. Sloping-top corner fillers, mitered.
- K. Plastic-Laminate Colors, Patterns, and Finishes:
 - 1. As selected by Architect from plastic-laminate manufacturer's full range of colors and patterns.

2.3 MATERIALS

- A. Certified Wood: Wood products shall comply with requirements of ASTM D7612-10 (FSC, SFI, ATSM, CSA or PEFC certifications are acceptable).
- B. Composite Wood: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
 - 1. Composite Wood Products: Products shall be made without urea formaldehyde.
 - 2. Thermally Fused Laminate (TFL) Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper.
 - 3. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
 - 4. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
- C. High-Pressure Decorative Laminate: ISO 4586-3, minimum grades as follows:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Postformed Surfaces: Grade HGP.
 - 3. Vertical Surfaces: Grade VGS.

- D. Adhesives: Do not use adhesives that contain urea formaldehyde.
- E. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- G. Anchors: Material, type, size, and finish as required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- H. Wood Support Base: 2-by-4-inch nominal-size umber treated with manufacturer's standard preservative-treatment, pressure process.

2.4 HARDWARE

- A. Cam Padlock Hasp: Surface mounted, steel; finished to match other locker hardware.
- B. Frameless Hinges (European Type): Fully concealed, self-closing, nickel-plated steel, with not less than 125 degrees of opening.
 - 1. Provide two hinges for doors 36 inches high and less.
 - 2. Provide three hinges for doors more than 42 inches high.
- C. Knobs: Metal; back mounted; 1-inch- diameter, flat round or ball shape.
- D. Accessible Handle: Metal, fixed, graspable lever handle and rose trim; surface mounted.
- E. Shelf Rests: BHMA A156.9, B04013.
- F. Hooks: Manufacturer's standard, ball-pointed aluminum or steel; chrome finished. Attach hooks with at least two fasteners.
- G. Exposed Hardware Finish:
 - 1. Satin chrome unless otherwise indicated.

2.5 ACCESSORIES

- A. Number Identification Plates: 1-1/2-inch- diameter, etched, embossed, or stamped, stainless steel plates with black numbers and letters at least 1/2 inch high. Identify lockers in sequence indicated on Drawings.

2.6 FABRICATION

- A. Fabricate each locker with shelves, an individual door and frame, an individual top, a bottom, and a back, and with common intermediate uprights separating compartments.
 - 1. Fabricate lockers to dimensions, profiles, and details indicated.
 - 2. Ease edges of corners of solid-wood members to 1/16-inch radius.
- B. Fabricate lockers square, rigid, without warp, and with finished faces flat and free of dents, scratches, and chips. Accurately factory machine components for attachments. Make joints tight and true.
 - 1. Fabricate lockers using manufacturer's standard construction, with joints made with dowels, dados, or rabbets. Dado side panels to receive shelving except where indicated to be adjustable.

2. Fabricate lockers with joints that are dadoed or rabbeted, glued full length, and stapled. Dado side panels to receive shelving except where indicated to be adjustable.
- C. Accessible Lockers: Fabricate as follows:
1. Locate bottom shelf no lower than 15 inches above the floor.
 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- D. Venting: Fabricate lockers with space between doors and locker assembly of not less than 1/4 inch.
- E. Number Identification Plates: Inlay number plates flush in each locker door, near top, centered.
- F. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that the parts fit as intended, and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
 2. Use only manufacturer's nuts, bolts, screws, and other devices for assembly.
- G. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- H. Attach PVC edging to panels by thermally fusing edging to panels after panel fabrication.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that furring is attached to concrete and masonry walls that are to receive lockers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Condition lockers to average prevailing humidity conditions in installation areas before installation.
- B. Before installing lockers, examine factory-fabricated work for completeness and complete work as required, including removal of packing.

3.3 INSTALLATION

- A. Install wood support base with 1/2-inch- thick, plywood top.
- B. Install lockers level, plumb, and true; use concealed shims.
- C. Connect groups of lockers together with manufacturer's standard fasteners, through predrilled holes, with no exposed fasteners on face frames. Fit lockers accurately together to form flush, tight, hairline joints.

- D. Install lockers without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings, providing unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Installation Tolerance: No more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line. Shim as required with concealed shims.
- E. Locker Anchorage:
 - 1. Fasten lockers through back, near top and bottom, at ends with No. 8 pan-head sheet metal screws through metal backing or metal framing behind wall finish and spaced not more than 16 inches o.c.
- F. Scribe and cut corner and filler panels to fit adjoining work using fasteners concealed where practical. Repair damaged finish at cuts.
- G. Attach sloping-top units to lockers, with end panels covering exposed ends.
- H. Install number identification plates after lockers are in place.
 - 1. Attach number identification plate on each locker door, near top, centered, with at least two screws with finish matching the plate.

3.4 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors to operate easily without binding. Verify that integral locking devices operate properly.

3.5 PROTECTION

- A. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- B. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105123

SECTION 107123 - EXTERIOR SUN CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel canopy with horizontal aluminum airfoil sunshades.
 - 2. Vertical-mounted aluminum airfoil sunshades in aluminum frame.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel Framing" for structural steel supports.
 - 2. Section 055000 "Metal Fabrications" for miscellaneous steel supports and bracing.
 - 3. Section 099600 "High-Performance Coatings" for painting of canopy steel support structure.

1.2 ACTION SUBMITTALS

- A. Product Data: Manufacturer's data sheets for each product and assembly specified.
- B. Shop Drawings: Submit documentation that illustrates sections and details showing profiles, spacing of components, frames and anchors.
 - 1. Include layout, spacings, sizes, thicknesses, and types of metal support framing and attachment to structure; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate supplemental framing, accessories, connection details, and attachment to adjoining work.
- C. Samples for Initial Selection: For each component where color and finish are indicated to be selected by Architect.
- D. Samples for Verification: For each finish and color indicated, two samples representing actual finishes specified.

1.3 QUALITY ASSURANCE

- A. Fabricator: Canopy systems shall be fabricated by a firm with a minimum of 5 years of experience in the design, engineering and fabrication of similar systems.
- B. Installer: Fabricator of canopy.
- C. Welding Qualifications: Qualify procedures and personnel according to the following as applicable:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Provide the following upon request:
 - 1. Qualification Data: For fabricator.
 - 2. Welding certificates.
 - 3. Product Test Reports: For each manufactured product and component, for tests performed by a qualified testing agency, including, but not limited to the following:
 - a. Brackets
 - b. Blades.
 - c. Mechanical fasteners.
- E. Mock-Up: Build freestanding mockup to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Erect mockup, approximately 100 sq. ft. using full size components. At a minimum, include finished steel columns, and steel frame with louver sunshades.
2. Provide units finished as specified.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle materials and products in compliance with manufacturer's instructions and recommendations and industry standards.
- B. Store products indoors in manufacturer's or fabricator's original containers and packaging, with labels clearly identifying product name and manufacturer. Protect from damage.

1.5 SEQUENCING AND SCHEDULING

- A. Field Measurements: Locate support structure and locations of connections to adjacent construction by field measurements before fabrication. Indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Established Dimensions: Where field measurements cannot be taken without delaying the Work, establish dimensions and proceed with fabricating products without field measurements, taking responsibility for any field adjustments required for installation. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.7 WARRANTY

- A. Special Finish Warranty, Factory-Applied Aluminum Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Canopies shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of metal components, noise or metal fatigue caused by airfoil-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 1. Wind and Seismic Loads: Determine loads based on pressures as indicated on Drawings.
- B. Seismic Performance: Canopies shall withstand the effects of earthquake motions determined according to ASCE/SEI7.

- C. Canopies shall be designed to perform under conditions specified herein or required by site conditions with no permanent damage to or deforming of the blades or sunshade assembly, noise or metal fatigue caused by blade rattle or flutter, or permanent damage to fasteners and anchors.
 - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
 - 2. Analysis of Blade Deflection to be limited to L/120, 3/4 inch, as indicated on structural drawings, or as required by code, whichever is most stringent.
- D. Canopies shall be installed to withstand wind and seismic loads, acting upwards and downwards.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SUN CONTROL DEVICES

- A. Louvered Sunshades: (LOU-1)
 - 1. Manufacturer: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. B&C Industrial Group, Inc.
 - b. Construction Specialties, Inc. (C/S Group)
 - c. DAMS, Inc.
 - d. Ruskin
 - 2. Basis-of-Design Products:
 - a. Construction Specialties, Inc.; CS Linear Sunshade System: Airfoil system mounted horizontally and vertically as indicated.
 - 3. Blade Shape: Airfoil
 - 4. Blade Material: Extruded aluminum.
 - a. Finish: Louver manufacturer's standard high-performance organic fluoropolymer coating.
 - 5. Blade Material Thickness: Not less than required by performance requirements.
 - 6. Blade Size: 10 inch high by 1 inch wide
 - 7. Blade Direction: As indicated on Drawings.
 - 8. Blade Mounting Angle: As indicated on Drawings.
 - 9. Structural Supports: Galvanized steel tubes per structural drawings.
 - a. Finish: High-performance paint according to Section 099600 "High-Performance Coatings."
 - 10. Fascia: As indicated.
 - 11. Mounting: Mechanically attached blades to steel angles welded to steel support framing designed to withstand performance requirements indicated. Louvers mechanically attached at angle indicated to galvanized steel angles. Angles welded to structural steel. Provide manufacturers standard attachments, brackets, tabs and fasteners, designed to withstand performance requirements indicated.

2.3 STEEL CANOPY FRAMING

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Structural Steel Tubes, Plates, Shapes, and Bars: Refer to Structural Drawings.
 - 1. Exposed steel shall be hot-dipped galvanized.

2.4 ALUMINUM

- A. Fabricate products from alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
- B. Aluminum Extrusions: ASTM B 221,
 - 1. Non-structural architectural extrusions: Alloy 6063-T5 or T6, as standard with manufacturer.
 - 2. Structural extrusions: Alloy 6061-T6.

2.5 MISCELLANEOUS MATERIALS AND FASTNERS

- A. Aluminum Fasteners: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for use with aluminum components. Select fasteners for type, grade, and class required and capable withstanding design loads.
- B. Steel Frame Bolts, Fasteners and Anchors, General: Refer to Structural Drawings.
- C. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

2.6 FABRICATION

- A. Maintain equal blade spacing to produce uniform appearance.
- B. Include supports, anchorages, flashings, and accessories required for complete assembly.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

- A. Aluminum Extrusions and Accessories:
 - 1. High-Performance Organic Finishes:
 - a. Two- or Three- Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat (Three-coat) as applicable. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - b. Color: As selected by Architect from louver manufacturer's standard colors and finishes, including micas and metallics.

2.9 STEEL AND IRON FINISHES

- A. Galvanized Steel:
 - 1. Prepare steel for galvanizing according to Section 099600 "High-Performance Coatings."
 - 2. Hot-dip galvanize steel canopy components indicated, including hardware, after fabrication.
 - 3. Comply with ASTM A123/A123M for hot-dip galvanized steel canopy components.

4. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
 5. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 6. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. Preparing Galvanized Steel for Finishing: After galvanizing, thoroughly clean galvanized steel components of grease, dirt, oil, flux, and other foreign matter using surface preparation standard SSPC-SP 16 "Brush-Off Blast Cleaning."
- C. Primer Application: Apply vinyl wash primer to prepared galvanized steel surfaces. Comply with requirements in SSPC-PA 1 for shop painting.
- D. Shop-Painted Finish: Comply with Section 099600 "High-Performance Coatings."
1. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.
 - a. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and structural support, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place canopy structure and louver sunshades level, plumb, and at indicated alignment with adjacent work.
- B. Install louvers according to manufacturer's instructions and approved Shop Drawings.
- C. Isolate aluminum from ferrous and zinc-coated metal with two coats of bituminous paint, flexible flashing tape or non-metal washers or gaskets.
- D. Use concealed anchorages where possible. Provide isolation washers fitted to screws where required to protect metal surfaces from galvanic corrosion.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed canopy and sunshade surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore sunshades damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.5 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 108113 - BIRD CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bird wire system.
 - 2. Bird netting.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for concrete substrates for bird control devices.
 - 2. Section 051200 "Structural Steel Framing" for structural-steel framing system components and substrate for bird control devices.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For bird control systems. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples:
 - 1. Bird Wire System: Full size samples of each type of base with posts attached to wire.
 - 2. Other samples: Only when requested.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle packaged materials in original containers with seals unbroken and labels intact until time of use.
- B. Store items in clean, safe, dry area.

1.4 COORDINATION

- A. Coordinate Work of this Section with related work.
- B. Schedule Work of this Section to occur after adjoining work has been completed, including finishing and installation of sealants.

PART 2 - PRODUCTS

2.1 BIRD WIRE

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Bird Barrier America, Inc.; Birdwire System.
 - 2. Bird-B-Gone; Bird Wire 2000.

- B. Description: Bird control system consisting posts and wires that provide an unstable landing area for pigeons, seagulls, and larger birds.
- C. Components:
 - 1. Wire: Seven-strand, stainless steel wire, coated with clear ultraviolet stabilized nylon.
 - 2. Base with Posts: Manufacturer's standard stainless steel base, designed for glue-on installation.
 - 3. Glue: As recommended by manufacturer.
 - 4. Spring: Stainless steel, sized as required.
 - 5. Crimps: Nickel plated copper.

2.2 BIRD NETTING

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Bird-B-Gone; Bird Net 2000.
- B. Description: Bird netting system including net and mounting/anchoring accessories.
- C. Components:
 - 1. Bird Net: Heavy-duty net, UV stabilized, rot proof and water proof; flame resistant.
 - a. Mesh Size: 3/4 inch.
 - 2. Mounting Accessories: Provide complete mounting accessories consisting of, but not limited to eyebolts, straining wire, ferrules, turnbuckle, hog rings, anchor rivets with split pin, and cable bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive bird control devices before installation.
- B. Field-verify dimensions and suitability of substrates for anchoring.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's recommendations and approved shop drawings.
- B. Bird Wire:
 - 1. Install end and intermediate base posts using glue. Do not use screws or drill holes into substrate. Location, number of rows, and spacing shall be as recommended by manufacturer. Intermediate posts shall be no more than 5 feet apart.
 - 2. Allow glue to set and cure thoroughly before installing wire.
 - 3. Install wire in lengths no more than 10 feet per section of wire. Terminate each section with spring. Next wire section may continue from the same post.
- C. Bird Netting:
 - 1. Mechanically fasten eyebolts, anchor rivets, and cable brackets. Adjust eyebolts, anchors, and cable brackets to maintain the recommended gap between the straining wire and the building structure.
 - 2. Loop end of straining wire through eye bolt and fasten using two ferrules.
 - 3. Loop other end of straining wire to turnbuckle. Attach to eye bolt and twist turnbuckle to apply tension.

4. Install netting to straining wire using hog rings. Stretch netting as recommended by manufacturers.

3.3 PROTECTION

- A. Protect Work from damage.
- B. Replace damaged or defective Work.

END OF SECTION

SECTION 112183 – PHOTO PROCESSING SINKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Photo Processing Sinks
 - a. Room 15101 - MQ.06
 - b. Room 15101A - MQ.05
 - c. Room 15101B - MQ.11
- B. Related Requirements:
 - 1. Section 123553 "General Requirements for Laboratory / Arts Casework and Fume Hoods" for references, coordination, submittal requirements, quality assurance, materials, hardware, finishes, service fixtures, installation, etc.
 - 2. Section 123553.26 Solid Phenolic Resin Photography Casework.
 - 3. Division 22: Furnishing and installation of plumbing utilities and final connections to photo processing sinks and equipment.
 - 4. Division 23: Furnishing and installation of vent hood and exhaust duct work and equipment and final connections to photo processing sink vent hoods.
 - 5. Division 26: Furnishing and installation of electrical utilities and final connections to photo processing sink equipment.

1.2 QUALITY ASSURANCE

- A. Single source responsibility: All systems and components, which comprise photo processing sinks and accessories, shall be designed, fabricated and assembled by a single manufacturer.
- B. Manufacturer's qualifications: Modern plant with proper tools, dies, fixtures and skilled workers to produce high quality, photo processing sinks and accessories, and shall meet the following minimum requirements:
 - 1. Ten years or more experience in manufacture of the type of equipment specified.
 - 2. Ten installations of equal or larger size and requirements.
- C. Installer's Qualifications: Factory trained and/or certified by the manufacturer.

1.3 REFERENCES

- A. The following industry, association and government codes and standards are cited in this Section. They shall be followed as applicable to the design, fabrication, assembly and testing of the specified equipment.
 - 1. American National Standards Institute (ANSI).
 - 2. American Society for Testing and Materials (ASTM).
 - 3. American Welding Society (AWS).
 - 4. Federal Occupational Safety and Health Act (OSHA).
 - 5. National Electric Code (NEC).
 - 6. National Electric Manufacturers Association (NEMA).
 - 7. National Fire Protection Association (NFPA).
 - 8. Underwriters Laboratory, Inc. (UL), for electrical safety and integrity.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products on the site in such a manner as to minimize the risk of damage, decay, deterioration or loss from theft.

- B. All products shall be delivered to the job site in manufacturer's original unopened containers, crates or protective wrappings with the manufacturer's name and address clearly labeled thereon.
- C. Schedule delivery of equipment so that spaces are sufficiently complete that equipment can be installed immediately following delivery.
- D. Accept products on site and inspect on arrival for damage.
- E. Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating.

1.5 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met.
 - 1. Windows and doors are installed and the building is secure and weathertight.
 - 2. Ceiling, overhead ductwork and lighting are installed.
 - 3. All painting is complete and flooring is installed.

1.6 ACTION SUBMITTALS

- A. Submittal Compliance Form: If Basis-of-Design products are provided, Submittal Compliance Form may be submitted in lieu of required Product Data submittal. Ensure compliance with requirements included in Section 013300 "Submittal Procedures."
- B. Product Data: Submit manufacturer's data for each item of equipment specified. Include dimensions, configurations, construction details, and attachments. Indicate location, size, and service requirements for each utility connection.
- C. Shop Drawings: Provide large scale plans and sections showing rough-in and anchor placements, clearances, and location of utilities for coordination with other trades.
 - 1. Indicate details for anchoring sinks to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Manufacturer's operating and maintenance manuals.

1.8 COORDINATION

- A. The supplier/installer shall coordinate the installation of all products under this section and shall coordinate the installation and rough-in sizes and locations for all utilities required with the appropriate trades.

1.9 WARRANTY

- A. Manufacturer's Warranty: Furnish manufacturer's written material and labor warranty signed by an authorized representative using manufacturer's standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. "Defects" is defined to include but not limited to deterioration or failure to perform as required. Coverage of warranty includes but is not limited to the following:
 - 1. Warranty Period: Manufacturer shall warrant the products to be free from material and labor Defects for a period of 1 year from date of Substantial Completion.

- B. Installer's Warranty: Furnish installer's written workmanship warranty signed by an authorized representative using installer's standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. "Defects" is defined to include but not limited to deterioration or failure to perform as required.
 - 1. Warranty Period: Installer shall warrant the installation to be free from workmanship Defects for a period of 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PHOTO PROCESSING SINKS

- A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
 - 1. Basis of Design: Sebastian Darkroom Products a Division of California Stainless MFG., Inc..
- B. Acceptable Manufacturers/Fabricators and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures":
 - 1. Sebastian Darkroom Products a Division of California Stainless MFG., Inc.
 - 2. Or Equal, No Known Equal
- C. Size: As scheduled and detailed on the Drawings.
- D. Service Requirements: As scheduled and detailed on the drawings.
- E. Construction:
 - 1. Each sink unit completely assembled and consists of the sink, sink base cabinet(s), pre-piped fittings, service fixtures, thermostatic water blenders, chillers, and filtration equipment and vent hood / shelf. .
 - 2. Fabricate from 16 gage, Type 304 stainless steel with a Number 4 finish. Provide 1 inch radius cove at vertical and horizontal corners and pitch bottom to drain(s). All sink joints to be butt welded, ground smooth and polished to render all joints seamless. Soldering will not be permitted in conjunction with sink unit construction. Provide all sink units designed and fabricated with sufficient reinforcement to prevent oil canning. Apply heavy mastic type sound deadening coating to underside of sinks, backsplashes, and sidesplashes covering a minimum of 80 percent of the affected surface area. Fixture holes to be reinforced with a continuous 14 gage hat channel.
 - 3. Provide with stainless-steel open-end overflow standpipe, strainer, and tailpiece. Standpipe to be 2 inches taller than bottom of sink.
 - 4. Include the following accessories as detailed on the drawings:
 - a. Temperature Blender: HydroGuard thermostatic water blender with strainer-check-stops, lever handle and 3 inch dial thermometer.
 - b. Water Filters: 20 micron incoming water filters mounted on a PVC panel with shut-off valves, spanner wrench and 3/4 inch unions. Provide one filter for incoming hot water and one filter for incoming cold water.
 - c. Tempered Water Faucets. Panel mounted TW/1 (refer to Service Fixture Schedule)
 - d. Eye Wash: Panel mounted swing down eye wash EW/1 and panel mounted swing-away eye wash EW/2 (refer to Service Fixture Schedule).
 - e. Flushing Rinse.

5. Chiller: Optional pending testing of water temperature during the height of summer months to confirm incoming water temperature remains consistently 62 degrees Fahrenheit or below. If needed provide each sink unit with an water-cooled water chiller. Chiller to chill 28 gallons per hour at 50 degree Fahrenheit based on incoming water at 80 degrees Fahrenheit. Chiller installation shall include piping and changeover valves, controls (refer to mechanical controls), and electrical connections.
6. Vent Hood: Provide gray polyvinyl chloride PVC vent hood with integral shelf over each sink.
 - a. Hood at wall sink to be supported by the wall.
 - b. Hood at walk-around sink to be supported by the sink and from the ceiling.
 - c. Vent stacks to be 8 inches in diameter. Include adjustable dampers with locking quadrants in each stack for on-site air balancing.
 - d. Vent stack to extend to 4 inches above the ceiling.
 - e. Dampers to be located just below the ceiling with damper handle swinging down (away from the ceiling) for open position.
 - f. Shelf to be a minimum of 10 inches deep with side splashes and front retainer lips.
7. Provide escutcheons on all duct, piping, controls, power, and structural support systems that penetrate the ceiling. Seal all floor penetrations.
8. Additional Requirements: No stickers or markings shall be on visible portions of the sinks, including the vent stacks, dampers, and shelves.
9. Refer to Section 123553.26 for base cabinets.
10. Refer to Section 123553 for service fixtures.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify equipment rough-in before proceeding with the work in this section.
- B. Coordinate with other trades for the proper and correct installation of plumbing and electrical rough-in, and structural backing for items attached to walls required for the installation of products in this section.
- C. Examine surfaces and conditions to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.2 INSTALLATION

- A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to the following, unless otherwise specified:
 1. Respective manufacturer/fabricator's written installation instructions.
 2. Accepted submittals.
 3. Contract Documents.
- B. Deliver to job site, uncrate, place in location, and assemble all equipment specified herein. Remove all debris and crating materials.
- C. Install equipment in strict accordance with the manufacturer's recommendations, including maintaining recommended operating and servicing clearances.
- D. Provide shutoff valves in all utility supply piping to the units.
- E. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

- F. Anchor equipment securely in place with a seismic tie-down kit, in accordance with design calculations and requirements..

3.3 SUPERVISION AND STARTUP

- A. Provide the services of the manufacturer's factory trained field representative to inspect and provide written approval of the installation.
- B. Include the services of the manufacturer's representative to start up and test the equipment. The manufacturer shall certify in writing that the equipment is operating according to specifications.

3.4 CLEANUP, MAINTENANCE, ADJUSTING AND DEMONSTRATION

- A. At completion, clean all surfaces thoroughly using no cleaners, which will harm adjacent surfaces.
- B. Protect all equipment and surfaces from damage and replace all damaged items.
- C. Adjust operating equipment to efficient operation for its intended use, and as required by the manufacturer.
- D. Include the services of the manufacturer's representative to instruct the Owner's operating personnel in the proper care and operation of the units.

3.5 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent damage to equipment from exposure to other construction activity

END OF SECTION

SECTION 115213 - PROJECTION SCREENS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes
 - 1. Motorized front projection screens.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications": Suspension systems for projection screens.
 - 2. Section 095100 "Suspended Acoustical Ceilings."
 - 3. Division 26 for electrical wiring, connections, and installation of remote control switches for electrically operated projection screens.

1.2 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Shop Drawings: Shop drawings showing layout and types of projection screens. Show the following:
 - 1. Location of screen centerline.
 - 2. Seams in viewing surfaces.
 - 3. Detailed drawings for concealed mounting.
 - 4. Connections to suspension systems.
 - 5. Anchorage details.
 - 6. Accessories.
 - 7. Frame details.
 - 8. Wiring diagram for electrically operated units.
- C. Certificate of Environmental Compliance: Documentation indicating fabrics meet or exceed the following field-validated standards set by UL GREENGUARD Environmental Institute (GEI) program for products and materials with low chemical and particle emissions for indoor usage.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches square, representing actual product, color, and patterns.

1.3 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain each type of projection screen required from a single manufacturer as a complete unit, including necessary mounting hardware and accessories.
- B. Coordination of Work: Coordinate layout and installation of projection screens with other construction supported by, or penetrated through, ceilings, including light fixtures, HVAC equipment, fire suppression system and partitions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver projection screens until building is enclosed for new construction, or demolition complete, and debris removed if it is a renovation.
- B. Deliver in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Inspect screens for freight damage, concealed or otherwise, upon delivery to project site. Report damage to freight carrier immediately for replacement of fixed projection screens.
- D. Store in manufacturer's unopened packaging until ready for installation.
- E. Protect screen surfaces from damage during delivery and storage and installation from abrasion, dust and other conditions.

1.5 COORDINATION

- A. Coordinate work with installation of ceilings, walls, electric service power characteristics, and location.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Basis Of Design
 - 1. Draper, Inc.; 411 South Pearl Street; Spiceland, IN 47385-0425; Phone 765.987.7999; www.draperinc.com
 - 2. LegrandAV (Da-Lite); 3100 North Detroit Street; Warsaw, IN, 46582; Phone 866.977.3901; www.legrandav.com/products/da-lite
- B. Other Acceptable Manufacturers
 - 1. Screen Innovations; 9715 Burnet Rd #400, Austin, TX 78758; 512.832.6939; www.screeninnovations.com
 - 2. DNP; RP Visual Solutions, 1275 S. Lewis St, Anaheim, CA, 92805; 714.991.6405; www.dnp-screens.com
 - 3. Stewart Filmscreen; 1161 Sepulveda Blvd; Torrance, CA 90502; 800.762.4999; www.stewartfilmscreen.com

2.2 MOTORIZED FRONT PROJECTION SCREENS

- A. Draper
 - 1. Basis-of-Design Product: Access V

- a. Electric motor operated, steel case. Ceiling-recessed, 18-gauge steel headbox, 7-3/8 inches high x 8-1/16 inches deep, including trim flanges with white paint finish and stamped 13-gauge steel end caps. UL approved "Suitable for use in environmental air space." Bottom closure panel forms slot for passage of viewing surface and can be released to hang down or be removed for access to operating mechanism and viewing surface. Bottom perimeter flange provides support and trim for acoustical ceiling panels and trim for gypsum board ceiling. Access case may be ordered in advance and the screen installed later to eliminate field damage. Screen installs in minutes. Housing is symmetrical allowing for left (standard) and right (optional) hand motor locations and for viewing surface to unroll off front or back of roller. Steel mounting brackets slide in extruded aluminum mounting system along top of case. Brackets supporting roller/fabric assembly slide in tracks inside top of the case, allowing viewing surface to be centered in case. Steel leveling brackets are attached to case to prevent deflection. Housing designed with internal junction box and plug-in wiring connections to allow housing to be installed and connected to building power supply separately from motor and viewing surface.
 - 1) Motor
 - a) Motor mounted inside screen roller on rubber isolation insulators. Motor UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches. Motor shall be left mounted (standard).
 - b) Quiet Motor mounted inside screen roller on rubber isolation insulators. Motor operates at 44db and is UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches. Motor shall be left mounted (standard).
 - 2) Viewing Surface
 - a) Draper TecVision XT1100X White - on axis gain of 1.1. 180 degree viewing cone.
 - b) Black Backing
 - c) Black Drop: As needed to align bottom of screen 30 inches above finished floor.
 - 3) Tab-Tensioning System
 - a) Viewing surface with integrated tabs and cable on each side of fabric to provide tension and ensure flat viewing surface. Viewing surface and tabs CNC cut as a single piece. Tabs RF welded to the back of viewing surface to prevent tab separation. Tab adhesives are not acceptable. Viewing surface inserted into aluminum bottom dowel.
 2. Screen Controls
 - a. General: All controls are UL Certified.
 - 1) Low voltage control unit with three button 24V switches and cover plate to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
- B. Da-Lite
1. Basis-of-Design Product: Tensioned Advantage
 - a. Ceiling Recessed electrically operated, UL and ULC listed, retractable, with rigid metal roller and tab guide cable screen tensioning system.
 - 1) Motor: Housed inside metal roller. Includes automatic thermal overload protection, integral gears, capacitor and electric brake to prevent coasting, and preset, adjustable limit switches to automatically stop viewing surface in the UP or DOWN positions.
 - a) Type: 3-wire, permanently lubricated, reversal type designed for mounting inside roller and to suit project requirements.

- b) Voltage, Frequency: 115 V, 60 Hz.
 - c) Amperage: 2.4 amps maximum.
 - 2) Screen Mounting: Ceiling Recessed with Trim Kit.
 - 3) Screen Case: Designed to receive mounting hardware and sized to suit projection screen.
 - a) Material: Extruded aluminum.
 - b) Design: 2-piece with curved contour flat-backed style with heavy-duty end caps concealing roller ends.
 - c) Finish: Powder coated white.
 - 4) Viewing Surface
 - a) Permanently attached to roller.
 - b) HD Progressive 0.9 - on axis gain of 0.90. 170 degree viewing cone. GREENGUARD Gold certified.
 - c) Black Backing
 - d) Black Drop: As needed to align bottom of screen 30 inches above finished floor.
 - 5) Tab Guide Cable Tensioned Screen Material:
 - a) Include tab and cable guide on each side of fabric to maintain even, lateral tension and hold viewing surface flat.
 - b) Bottom end of fabric to be inserted into a custom aluminum slat bar with added weight to provide vertical tension on the screen surface.
 - c) Slat ends to be protected by heavy-duty plastic caps enclosing a preset adjustable mechanism for screen tensioning.
 - 6) Installation Hardware: Fasteners and other components of type, size and spacing recommended by manufacturer for complete, functional and secure installation of electric screen.
 - 7) Closure Door
 - a) Screen shall include a second motor 120V (60Hz) 1.2 Amp.
 - b) The door will lift to the closed position where a micro switch shall cut off the electrical current to the door motor
2. Screen Controls
- a. Silent Motor with Integrated Low Voltage Control System (LVC)
 - b. Switch: 3 position type with cover plate for UP, DOWN and STOP functions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify rough-in openings are properly prepared.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install projection screens at locations indicated to comply with the manufacturers written instructions.
- B. Install projection screens with screen cases in position and in relationship to adjoining construction as indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when the screen is in the lowered position.
- C. Site-assemble screen frames, stretch viewing surface over frame and attach with attachment system. Exercise care to ensure viewing surface is not soiled or damaged and that surface is taut.
- D. Test electrically operated units to verify that the screen, controls limit switches, closure, and other operating components are in optimum functioning.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion

END OF SECTION

SECTION 115300 - MISCELLANEOUS LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinet, Tall Corrosive and Base Storage.
2. Cabinet, Tall Flammable Storage.
3. Drying Rack.
4. Drying Rack, Bench Top Mounted.
5. Ice Machine, Upright.
6. Point Exhaust.
7. Point Exhaust, Atomic Absorption Unit.
8. Sink, Hand Wash.
9. Backdrop Organizer
10. Built-in Transparency Viewer with Control Box
11. Overhead Single-Head Light with Camera
12. Goggle Storage , Wall mounted
13. Single Adjustable Monitor Arm
14. Dual Adjustable Monitor Arm

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for furnishing and installation of metal fabrications to casework and accessory equipment.
2. Section 092216 "Non-Structural Metal Framing" for furnishing and installation of non-structural metal framing to casework and accessory equipment.
3. Division 22: Furnishing and installation of plumbing utilities and final connections to accessory equipment.
4. Division 23: Furnishing and installation of exhaust ductwork and equipment, and final connection to exhaust devices.
5. Division 26: Furnishing and installation of electrical utilities and final connections to casework and accessory equipment.

1.2 REFERENCES

A. Items specified as a part of this section must conform, where applicable, to the following standards.

B. American National Standards Institute (ANSI)

1. ANSI/UL 3101-1 – Electrical Equipment for Laboratory Use; Part 1: General Requirements

C. Underwriters Laboratories, Inc. (UL)

1. 1262 – Laboratory Equipment

D. American Society for Testing Materials (ASTM)

1. ASTM A167 for Stainless Steel, Alloy 302 or 304.
2. ASTM E84 for Burning Characteristics of Building Materials.
3. ASTM MT1010 for Support Columns

E. NSF International (NSF)

1. Standard #49.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's data for each component and item of laboratory equipment specified. Include component dimensions, configurations, construction details, joint details, and attachments. Indicate location, size and service requirements for each utility connection.
- B. Shop Drawings: Include the following:
 - 1. Location of assemblies in each room and layout for roughing-in, including utility connections and related diagrams.
 - 2. Details of fabrication and installation.
 - 3. Dimensional locations for rough-in of mechanical and electrical services.
 - 4. Model numbers indicated in this section to include all standard features listed in latest catalog or Website at date of submittal.
 - 5. Indicate details for anchoring equipment to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Manufacturer's operating and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Manufacturer shall have at least 5 years' experience in the fabrication of the specified equipment and shall have 10 installations of equal or larger size.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Schedule delivery of equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.
- B. Handling: Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating through-out the remainder of construction.

1.7 FIELD CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:
 - 1. Windows and doors are installed and the building is secure and weathertight.
 - 2. Ceiling, overhead ductwork, and lighting are installed.
 - 3. All painting is completed and flooring is installed.
- B. Field Measurements: Take field measurements to verify or supplement dimensions indicated. Be responsible for accurate fit of the Work. Verify that all equipment in this section is coordinated to provide a complete working process and system integration.

1.8 WARRANTY

- A. Manufacturer's Warranty: Furnish manufacturer's written material and labor warranty signed by an authorized representative using manufacturer's standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. "Defects" is defined to include but not limited to deterioration or failure to perform as required.
 - 1. Warranty Period: Manufacturer shall warrant the products to be free from material and labor defects for a period of 1 year from date of operational acceptance by the Using Agency.

2. Date of operational acceptance shall be after factory check, test and start-up services is complete, the unit is operating in a satisfactory manner, and the equipment has been satisfactorily commissioned by the Using Agency.
 3. The Using Agency will perform routine maintenance as described in the Manufacturers Standard Operation and Maintenance manuals during the warranty period. Using Agency performance shall in no way invalidate said warranties.
- B. Installer's Warranty: Furnish installer's written workmanship warranty signed by an authorized representative using installer's standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. "Defects" is defined to include but not limited to deterioration or failure to perform as required.
1. Warranty Period: Installer shall warrant the installation to be free from workmanship Defects for a period of 1 year from date of operational acceptance by the Using Agency.

1.9 COORDINATION AND UTILITIES VERIFICATION

- A. Utilities and connections may vary between approved manufacturers. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.
1. All utilities for these items are indicated in mechanical and electrical documents, the Equipment Schedule, and are referenced in Divisions 20, 21, 22, 23 and 26. Any deviations from these utilities must be documented within bid and shop drawing submittals.
 2. The Contractor is responsible for verifying field conditions, final services, connections and locations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Acceptable Manufacturers/Fabricators and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures".
- B. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
- C. Basis of Design: As indicated in schedule on the drawings. If no schedule, then the first manufacturer listed in each Article shall be the basis of design.

2.2 PERFORMANCE REQUIREMENTS

- A. Design Intent: Drawings and Specifications indicate design intent for products and systems and do not necessarily indicate or specify total Work required and shall not be construed as an engineered design. Furnish and install all Work required for a complete installation.
- B. Coordination of Contract Documents and Work:
1. Product Variations: In the event of minor differences between products and systems of acceptable or available manufacturer/fabricators, Contractor shall notify Architect of such differences and resolve conflicts in a timely manner. Failure of Contractor to provide notification shall be construed as acceptance of conditions indicated, and changes caused by minor differences between products and Contract Documents shall be included in the Work at no additional cost to Owner.

2. Allowable Adjustments: Minor dimension and profile adjustments may be made in interest of fabrication or erection methods or techniques or ability to satisfy design intent, provided design intent is maintained as determined by Architect. Proposed deviations shall include a detailed analysis of impact to adjacent substrates or other building systems, including related design or construction cost impacts. If accepted by Architect, deviations causing changes in materials, constructability, substrates, or conditions shall be included in the Work at no additional cost to Owner.

2.3 CABINET, TALL CORROSIVE AND/OR BASE STORAGE (T__N AND/OR T__B)

- A. Acceptable Manufacturers:
 1. Justrite Manufacturing Company, L.L.C.
 2. Eagle Manufacturing Company.
 3. Securall.
- B. Capacity:
 1. 17 gallons (83 liters) - 43 inches (591 mm) wide by 18 inches (455 mm) deep by 24 inches (1650 mm) high (piggyback version).
 2. 22 gallons - 23.25 inches wide by 18 inches deep by 65 inches high.
 3. 45 gallons- 43 inches wide by 18 inches deep by 65 inches high.
 4. 110 gallons- 59 inches wide by 34 inches deep by 65 inches high.
- C. Design: Construct cabinet in accordance with OSHA Regulations and the requirements of International Fire Code, Chapter 50 Hazardous Materials. Provide cabinets Factory Mutual (FM) approved or Underwriters Laboratories (UL) listed or as constructed below.
- D. Casing: Bottom, top, back, door, and sides of cabinet, minimum 18 gage sheet steel, double walled with 1-1/2 inches air space. Rivet or weld joints airtight. Provide with adjustable zinc plated leveling legs.
- E. Door: Provide with continuous piano hinge and a 3-point latch arrangement with door sill raised at least 2 inches above the bottom of the cabinet to retain spilled liquid within the cabinet. Provide self-closing self-latching door(s) with fusible link(s) to hold doors wide open and melt at 74 degrees Celsius for automatic closure. Provide with keyed lock.
- F. Ventilation: Provide a 2 inches threaded vent connection on each side of the cabinet for supply and exhaust ventilation air. Provide flame arrestors at supply and exhaust connections to cabinet.
- G. Shelving: Provide with three 18 inches deep, full width adjustable shelves. Provide each shelf with 1/4-inch thick heat welded, polypropylene or ABS plastic pan, liquid tight, removable, 1 inch deep.
- H. Liner: Provide cabinet with ChemCor thermoplastic coating on all interior surfaces as provided on the Justrite Centura line or similar.
- I. Identification: Mark all corrosive storage cabinets with conspicuous red lettering on a contrasting background: HAZARDOUS—KEEP FIRE AWAY.
- J. Color: Dark blue.
- K. Finish: Provide as specified for Metal Finishes in Section 123553.

2.4 CABINET, TALL FLAMMABLE STORAGE (T__F)

- A. Acceptable Manufacturers:
 1. Justrite Manufacturing Company, L.L.C.
 2. Eagle Manufacturing Company.
 3. Securall.

- B. Capacity:
 - 1. 22 gallons - 23.25 inches wide by 18 inches deep by 65 inches high.
 - 2. 45 gallons- 43 inches wide by 18 inches deep by 65 inches high.
 - 3. 110 gallons- 59 inches wide by 34 inches deep by 65 inches high.
- C. Design: Construct cabinet in accordance with OSHA Regulations and the requirements of NFPA 30, National Fire Protection Association, Flammable and Combustible Liquids Code.
- D. Casing: Bottom, top, back, door, and sides of cabinet shall be at least 18 gage sheet steel, double walled with 1-1/2 inch air space. Joints shall be welded airtight. Provide with adjustable zinc plated leveling legs.
- E. Door: Provide with continuous piano hinge and a 3-point latch arrangement with door sill raised at least 2 inches above the bottom of the cabinet to retain spilled liquid within the cabinet. Provide self-closing self-latching door(s) with fusible link(s) to hold doors wide open and melt at 74 degrees Celsius for automatic closure. Provide with keyed lock.
- F. Ventilation: Do not ventilate cabinet unless required by local authorities. Seal vent openings with plugs, supplied by the manufacturer.
- G. Shelving: Provide with three 18 inch deep, full width adjustable shelves.
- H. Grounding: Provide a grounding lug connection at lower right side of cabinet.
- I. Identification: All flammable storage cabinets shall be marked with conspicuous red lettering on a contrasting background: FLAMMABLE—KEEP FIRE AWAY.
- J. Color: Yellow.
- K. Finish: Provide as specified for Metal Finishes in Section 123553 except interior shall be triple epoxy coated.

2.5 DRYING RACK (DR3024)

- A. Available Manufacturers:
 - 1. Mod-Rack by Inter-Dyne; Model V3024.
 - 2. Or Equal (No Known Equal).
- B. Body: One-piece, 20 gage, Type 304 stainless steel with a Number 4 finish. Provide top with two 90 degree bends and sides with one 90 degree bend. Bottom shall have two 90 degree bends to provide an integral drip trough and catch drain. Provide front with a multiple of T-shaped holes to accommodate pegs.
- C. Pegs: Injection molded white polypropylene, 1/2 inch diameter by 6 inches long. T-shaped protrusion on base of pegs shall allow easy removal and replacement without need for tools. Design T-shaped holes to fit protrusion on support pegs for holding single or multiple utensil drip trays, drain shelves, funnel racks, or pipette holders. Provide five 2-3/4 inch peg extenders for each drying rack.
- D. Drip Trough: 4 inch wide, 20 gage, Type 304 stainless steel with a 3/8 inch OD stainless drain tube and a stainless steel screen insert. Screen; 16 gage, 14 by 14 mesh, 0.025 wire. Provide with a 3/8 inch ID flexible drain tube minimum of 30 inches long.
- E. Provide with hanger to allow removal and replacement of entire rack for cleaning without need for tools.
- F. Finished Backs: Provide with all units not mounted on walls. Fabricate from 20 gage, Type 304 stainless steel with a Number 4 finish.

2.6 DRYING RACK, BENCH TOP MOUNTED (DRBT)

- A. Available Manufacturers:
 - 1. Heathrow Scientific Global, Model HS23243A.
 - 2. Or Equal (No Known Equal).
- B. Description: Self-supporting, spot-welded HDPE-coated steel wire with polystyrene tray and back. Provide with removable bottom drainage pan.

2.7 ICE MACHINE, UPRIGHT (MQ-04)

- A. Acceptable Manufacturers:
 - 1. Scotsman Ice Systems; Model F0522 & Bin B842S.
 - 2. Hoshizaki Europe B.V.; Model F-500BAJ.
 - 3. Manitowoc Ice; Model UFP0200A.
- B. Size:
 - 1. Machine: 21 inches wide by 22 inches deep by 22 inches high.
 - 2. Storage Bin: 48 inches wide by 32 inches deep by 40 inches high.
- C. Description: Air cooled compressor/condenser, flake ice machine with storage bin. Storage bin to include four legs and bin top.
- D. Capacity: Ice making capacity of 450 pounds in 24 hours. 1/2 horsepower with a bin storage capacity of 500 pounds.
- E. Finish: Provide all units in stainless steel.
- F. Electrical: 120/60/1, 15 amp. Provide with grounded cord and plug.

2.8 POINT EXHAUST (PE-01 AND PE-01a)

- A. Available Manufacturers:
 - 1. Movex Inc.; Model; 3MiniTEX 1500 with dome hood MK 350.
 - 2. Nederman; Model; FX2 100 Original.
 - 3. Airflow Systems Inc.; Model; E-Z ARM II.
- B. Description: 3 inches diameter by 60 inches long self-supporting telescopic arm.
- C. Construction: Aluminum tubes connected with jointed elbows. Provide internal stainless steel support spring as recommended by the manufacturer. Provide arm with polypropylene mini hood and clear combi hood with outside dimension of 15-inch by 18-inch, and external collar for duct coupling. Provide connection to existing ductwork which will allow an unrestricted 360-degree movement of the arm.
- D. Jointed Elbows: Provide polypropylene with glass fiber reinforcement with 90-degree radius elbows and knurled adjusting knobs supported by ball bearings. The two outermost elbow joints shall rotate and swivel through 360-degrees. Provide adjustable external locking rings at each joint.
- E. Inlet Hood: Provide with 14 inch diameter clear dome hood inlet hood.
- F. Mounting bracket: Provide a wall or ceiling mounting bracket for each point exhaust. Mount so the bottom of upper jointed elbow is at 6 foot, 6 inches above the floor, to provide full service at desktop level.

- G. Air flow control: Any such device on the point exhaust arm such as a manual damper that restricts or stops allows air flow through the point exhaust arm is not acceptable. This device must be removed.
- H. Finish: Epoxy powder coated white.

2.9 POINT EXHAUST, ATOMIC ABSORPTION UNIT (PE-02)

- A. Available Manufacturers:
 - 1. Movex Inc.; Model; MEX-AAF.
 - 2. Airflow Systems Inc.; Model; Custom High Temp E-Z ARM II Stainless Steel.
 - 3. Or Equal (No Known Equal).
- B. Telescopic design with a 4 inch diameter sliding into a 5 inch diameter by 43 inches long extended self supporting arm. Tube and 10 inch diameter conical hood type 316L stainless steel, supporting bracket mild steel epoxy powder coated white. Sliding lining material PTFE, adjustable friction locking device.
- C. Flexible Duct: High-Temp Aluminum-coated glass fabric flexible duct, 6 inches diameter with a temperature range of -200 degrees to +1,000 degrees Fahrenheit. Basis of Design: McMaster-Carr Number 45825K74.
- D. Inlet Hood: Provide with 10 inch by 19 inch rectangular metal inlet hood.
- E. Mounting bracket: Provide an adjustable wall mounting bracket for each point exhaust. Mount so the bottom of upper pivot joint connector is at 6 foot, 6 inches above the floor, to provide full service at desktop level.
- F. Air flow control: Any such device on the point exhaust arm such as a manual damper that restricts or stops allows air flow through the point exhaust arm is not acceptable. This device must be removed.

2.10 SINK, HAND WASH (LSK-04)

- A. Acceptable Manufacturers:
 - 1. Just Manufacturing Company; Model A-33338.
 - 2. Elkay Manufacturing Company; Model ELVWO2219.
 - 3. StainlessUSA – Blue Steel, LLC; Model HS.
- B. Nominal Size: 20 inches long by 18 inches wide by 5 inch deep.
- C. Construction: Stainless steel wash up sink with ledge back, self rimmed lavatory of 18 gage, Type 304, steel. Rectangular compartment shall have radius coved corners. All exposed surfaces hand blended to a uniform satin finish. Underside sound dampened. Sink to be furnished with overflow, strainer and tailpiece.
- D. Refer to Drawing for location, type and number of fittings

2.11 BACKDROP ORGANIZER (MQ-02)

- A. Acceptable Manufacturers:
 - 1. Stacker Original. Model: White
 - 2. Or Equal (No Known Equal)
- B. Nominal Size: 20 inches wide by 14 inches deep by 10 inches high
- C. Description: Laser cut, powder coated steel divided into four even compartments that hold three backdrops in each compartment.

- D. Refer to Drawing for location, type and number of units.

2.12 BUILT-IN TRANSPARENCY VIEWER WITH CONTROL BOX (MQ-03)

- A. Acceptable Manufacturers:
 - 1. GTI Graphic Technology. Model: GraphicLite Recessed Viewer RVA-44 & LiteGuard Control Box LG-III
 - 2. Or Equal (No Known Equal)
- B. Nominal Size: 49 inches wide by 21 inches deep by 5 inches high
- C. Description: Built-in transparency viewer consting of acrylic faceplate, reflector assembly complete with Graphiclite tubes and line cord, two side reflectors. The LiteGuard control box sits on the counter top and controls the viewer. The RVA cord routes through the bench top gromment into the back of the LiteGuard and then the LiteGuard is plugged into a wall outlet.
- D. Refer to Drawings for location and details.

2.13 OVERHEAD SINGLE-HEAD LIGHT WITH CAMERA (MQ.08)

- A. Acceptable Manufacturers:
 - 1. Steris. Model: Harmony Air A-Series Surgical Light, Camera Ready Single Head, with 4K In-light Camera
 - 2. Getinge. Model: PowerLED II Surgical Light, Camera Ready Single Head, with 4K In-light Camera
 - 3. Stryker. Model: Oculan Surgical Light, Camera Ready Single Head, with 4K In-Light Camera
- B. Nominal Size: Nominal 43 inch length with 27 inch drop tube.
- C. Description: Single surgical light, LED technology with white or variable color lighting control with integral 4K in-light camera and integrated wall control. Aluminum construction with suspension system, spring arm with continuous braking and light head. Provide structural mounting.
- D. Electrical: 120 volt, Single Phase, with dedicated breaker and ground and all interconnected wiring between light and wall control.
- E. Data: Include interconnected cabling for transmission of images to adjacent labs.
- F. Refer to Drawings for location

2.14 SAFETY GLASS HOLDER WITH DOORS, WALL MOUNTED (MQ.01)

- A. Acceptable Manufacturers:
 - 1. Sellstrom / SureWerx USA, Inc. Model Monitor 2000 Germicidal Cabinet
 - 2. Carolina Biological Supply Company Model 646846
 - 3. Flinn Scientific Model SE1000
- B. Nominal Size: 25 inches wide by 32 inches tall by 10 inches deep.
- C. Description: 22 gauge metal cabinet construction with enameled finish and keyed lock. Includes 8 shelves each holding 5 goggles or 6 safety glasses. Provide UV lamp with 5 minute timer with pilot light switch and automatic shut-off if doors are opened. Wall mounted with 7 foot grounded cord and plug.
- D. Electrical: 120 volt, Single Phase, 5 amps.

- E. Refer to Drawings for location.

2.15 SINGLE ADJUSTABLE MONITOR ARM (MQ.09)

- A. Acceptable Manufacturers:
 - 1. Mount-It: Model MI-6352 LT Single-Arm Laptop Desk Mount
 - 2. ATDEC: Model AWMS-NDB
 - 3. Ergotron: Model LX
- B. Description: Single-arm, height adjustable, 360 degree swivel, 90 degree tilt with vented tray for laptops up to 17 inches and 13 pounds. Arm is gas spring with concealed cord management and bolt-through grommet mounting. Laptop tray has traction pads and tabs with locking buckles. Full arm extends to 23.5 inches to comply with accessible reach ranges.
- C. Finish: Black.
- D. Refer to Drawings for location and type.

2.16 DUAL ADJUSTABLE MONITOR ARM (MQ.10A & MQ.10B)

- A. Acceptable Manufacturers:
 - 1. Mount-It:
 - a. MQ.10A: MI-6352 LTMN Dual-Arm with (2) MI-3773B_G10 Anti-theft Tablet Holders
 - b. MQ.10B: MI-6352 LTMN Dual-Arm with (2) MI-2352T Laptop Holders
 - 2. ATDEC: Model AWMS-NDB
 - 3. Ergotron: Model LX
- B. Dual-Arm: Arms are height adjustable, 360 degree swivel, 90 degree tilt, gas springs with concealed cord management and bolt-through grommet mounting. Each arm has a full arm extension to 23.5 inches to comply with accessible reach ranges.
- C. Description Tablet Holder: Adjustable anti-theft VESA mount for iPad generations 7 through 10, iPad Air and iPad Air Pro.
- D. Description Laptop Holder: VESA mount vented tray for laptops up to 17 inches and 13 pounds. Laptop trays have traction pads and tabs with locking buckles.
- E. Finish: Black.
- F. Refer to Drawings for locations, and types.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.2 INSTALLATION, GENERAL

- A. Installation Quality Standards: Perform Work according to following, unless otherwise specified:

1. Respective manufacturer/fabricator's written installation instructions.
 2. Accepted submittals.
 3. Contract Documents.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by isolating metals and other materials from direct contact with incompatible materials.
- C. Coordinate delivery of all equipment with building work and scheduling for final placement.
- D. Check project for conditions that affect work. Do not begin installation until unsatisfactory conditions are corrected.
- E. Anchor laboratory equipment securely in place with appropriate seismic tie-down kits, in accordance with design calculations and requirements.

3.3 PREPARATION

- A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

3.4 INSTALLATION

- A. Miscellaneous laboratory equipment shall be installed in strict accordance with the manufacturer's recommendations, including recommended operating and servicing clearances.
- B. Plumbing hookups under Division 22.
- C. Mechanical hookups under Division 23.
- D. Electrical hookups under Division 26.

3.5 ADJUSTING

- A. Touch up damaged finishes equal to original condition as approved
- B. Repair or remove and replace defective work as directed by Architect upon completion of installation.
- C. Adjust moving or operating parts to function smoothly.

3.6 CLEANING AND PROTECTION

- A. Clean shop finished equipment, touch up as required, and remove and refinish damaged or soiled areas.
- B. Cover equipment for protection against soiling and deterioration during remainder of construction period.
- C. Equipment shall be protected before, during and after installation. Damaged materials due to improper protection shall be cause for rejection.

END OF SECTION 115300

SECTION 115313 - LABORATORY FUME HOODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Benchtop Chemical Fume Hoods.
 - 2. Accessible Fume Hoods.
- B. Related Requirements:
 - 1. Section 123553 "General Requirements for Laboratory / Arts Casework and Fume Hoods" for references, coordination, submittal requirements, quality assurance, materials, hardware, finishes, installation, etc.
 - 2. Division 22: Furnishing and installation of plumbing utilities and final connections to fume hoods.
 - 3. Division 23: Furnishing and installation of exhaust duct work and equipment, and final connection of fume hoods.
 - 4. Division 23: Furnishing and installation of exhaust controls and final connections to hoods.
 - 5. Division 23: "Testing, Adjusting, and Balancing for HVAC" for field quality-control testing of fume hoods.
 - 6. Division 26: Furnishing and installation of electrical utilities and final connections to fume hoods.

1.2 DESIGN REQUIREMENTS

- A. Comply with SEFA 1 "Laboratory Fume Hoods."
- B. Factory UL 1805 Classified. Provide each fume hood with UL 1805 Classified labeling.
- C. Fume hoods shall function as ventilated, enclosed workspaces, designed to capture and confine exhaust fumes, vapors and particulate matter produced or generated within the enclosure.
- D. Manufacturers to provide high performance fume hoods. Hoods which achieve a reduction in volumetric flow by restricting the sash opening area do not qualify as High Performance fume hoods unless they also meet the performance requirements through the maximum sash opening. The "maximum sash opening" shall be considered a vertical sash opening not less than 25 inches high off the fume hood work surface.
 - 1. High Performance Fume Hoods are hood designs that provide a reduction in the required exhaust air volume, when compared to the volume required for the same size fume hood to operate with a face velocity of 100 FPM through a fully opened vertical sash and provides containment levels equivalent or superior to ASHRAE 110 tracer gas test ratings of 4.0 AM 0.05, and 4.0 AI/AU 0.10, with a face velocity of 60 FPM or less through the fully opened vertical sash.
- E. Design fume hoods for consistent and safe air flow through the hood face. Negative variations of face velocity shall not exceed 10 percent of the average face velocity at any designated measuring point as defined in this section.
- F. Average illumination of work area: Minimum 80 foot candles. Work area shall be defined as the area inside the superstructure from side to side and from face of baffle to the inside face of the sash, and from the working surface to a height of 28 inches.
- G. Maximum average static pressure loss readings taken three diameters above the hood outlet from four points, 90 degrees apart not to exceed:

Face Velocity (FPM)	Measured Static Pressure Loss (WG)
75	0.18 inches
100	0.30 inches

125	0.45 inches
150	0.60 inches

- H. Fume hoods shall be constructed in such a manner as to cause no perceptible increase in sound pressure level over the mechanical exhaust system.
- I. Fume hood to have set baffle system. No manually adjustable baffles allowed.

1.3 ACTION SUBMITTALS

- A. Refer to Section 123553 and as noted below.
- B. Product Data: Submit manufacturer's data for each item. Include component dimensions, configurations, construction details, and attachments. Indicate location, size, and service requirement for each utility connection.
- C. Shop Drawings: Include the following:
 - 1. Indicate locations and types of service fittings together with associated service supply connection required.
 - 2. Indicate duct connections, electrical connections, and locations of access panels.
 - 3. Include layout of fume hoods in relation to lighting fixtures and air-conditioning registers and grilles.
 - 4. Indicate details for anchoring fume hoods to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.

1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 123553 and as noted below.
- B. Certifications: All manufacturers to test and certify their products to meet UL1805, ASHRAE 110 and SEFA 1.
- C. Test Reports: Submit complete reports verifying conformance to performance standards outlined in this specification when tested to the ASHRAE 110 Standard in the "As Manufactured" environment.

1.5 CLOSEOUT SUBMITTALS

- A. Refer to Section 123553 and as noted below.
- B. Operator Training Guide: Provide an electronic training presentation, highlighting the proper operating practices of the laboratory fume hood.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Acceptable Manufacturers/Fabricators and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures".
 - 1. Air Master Systems Corporation.
 - 2. ICI Scientific.
 - 3. Kewaunee Scientific Corporation.
 - 4. Mott Manufacturing Limited.

- B. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
- C. Furnish and install casework, fume hoods, furnishings and equipment specified in the following sections by the same supplier.
 - 1. Section 123553 "General Requirements for Laboratory / Arts Casework and Fume Hoods."
 - 2. Section 123553.13 "Stainless Steel Laboratory Casework."
 - 3. Section 123553.19 "Wood Laboratory and Arts Casework."
 - 4. Section 115300 "Miscellaneous Laboratory Equipment."
 - 5. Section 115313 "Laboratory Fume Hoods."

2.2 MATERIALS

- A. Refer to Section 123553.

2.3 BENCH TOP CHEMICAL FUME HOODS

- A. Superstructure:
 - 1. Wall: Rigid, self-supporting double wall assembly, nominally 5 inches thick. Double wall shall consist of a sheet steel outer shell and a corrosion resistant inner liner and shall house and conceal steel framing members, attaching brackets and remote operating service fixture mechanisms and services. Hoods shall be completely factory assembled to form a rigid, self-supporting structure.
 - 2. Face Opening Perimeter Edge: Air foil or streamlined shape with all right-angle corners radiused or angled.
 - 3. Interior Hood Height: 48 inches minimum to hood roof.
 - 4. Bypass: Low resistant down draft type. Bypass air shall enter at horizontal full length opening at the top front superstructure to enter hood in a down flow direction. Directional louvers are not acceptable. Material to match fume hood interior liner.
 - a. Restricted Bypass: Provide on all variable volume or constant volume hoods with combination sashes and on all variable volume hoods with a vertical rising sash.
 - 5. Ceiling Enclosure Panel: Used to enclose space between top of fume hood and ceiling on all exposed or open sides. Minimum 18 gage thick, finish to match hood. Extend to within 1 inch below ceiling for suspended ceiling to continue over fume hood enclosure panels for a finished look. Provide a lower removable front panel for access to hood lights, piping and exhaust duct connections.
 - 6. Interior and Exterior Fastening Devices: Conceal all devices. Exposed screws not acceptable. Unexposed structural member attachments: sheet metal screws, zinc plated.
- B. Sill Airfoil:
 - 1. Bypass type designed to prevent reverse air flows or air eddies at the fume hood work surface. Low profile, flush with work surface, notched or hinged to allow pass-through of hospital grade electrical plugs. Sill to include an integral spill trough for secondary containment. Provide a chemical resistant sealant between sill and work surface.
 - 2. Material: All components 16 gage thick Type 316 stainless steel, with an acid and abrasion resistant electrostatic epoxy or urethane powder coating.
- C. Sash:
 - 1. Full view type with clear, unobstructed, side to side view of fume hood interior and service fixture connections. Vertical rising or combination vertical rising/horizontal sliding. Refer to Fume Hood Schedule for type and height of sash at each fume hood.

2. Sash shall be aerodynamically designed, all stainless-steel components with chemically resistant polyurethane powder coat finish, with either frameless vertical rising style or combination style with both vertical and horizontal moving glass panels.
 3. Vertical Rising Sash: Provide sash stops at the design sash opening.
 4. Counterbalance system: Single weight, pulley, cable or chain and sprocket, counter balance system shall prevent sash tilting and permit one finger operation at any point along full width pull. Design system to hold sash at any position without creep and prevent sash drop in the event of cable failure. Sash and counterbalance mechanism to be life cycle tested to withstand a minimum of 100,000 cycles without signs of fatigue. Open and close sash against rubber bumper stops.
 5. Sash glass: 7/32-inch thick laminated safety glass.
 6. Sash guides: Corrosion resistant polypropylene.
- D. Automatic Sash Closure Mechanism:
1. Provide by fume hood manufacturer and install in fume hood manufacturing facility. Pre-wire mechanism to the top of the fume hood along with other electrical devices on the hood.
 2. Automatically closes sash to fully closed position using infrared occupancy sensor with user-programmable time-delay. Programmable in one second increments. Set delay to 30 minutes.
 3. Electrically actuated mechanism designed to engage both sides of the sash evenly to ensure smooth sash movement. Mechanism to utilize no more than 1 amp AC when actuated.
 4. Incorporate infrared light curtain detection system which stops the sash from closing and turns on a red obstruction indicator light. Infrared light curtain must detect any obstruction in the path of the sash from full-open to full-close. Provide with red obstruction indicator light that will turn off when reset button is pressed. Provide additional switch to engage and disengage the sash operator.
- E. Liners: Fiberglass reinforced polyester panel, 1/4 inch thick, smooth finish and white color in final appearance. Flame spread: 25 or less per UL 723 and ASTM E84-80. Manufactured by WS Hampshire Inc. "Wesliner 1125" or equal. Provide gasketed access panels in the liner for access to valves and fixtures. Panels shall be of the same material as the liner and be provided with a PVC gasket to eliminate air leakage and retain liquids inside the hood.
- F. Baffles: Provide fixed baffles to control air vectors into and through the fume hood. Fabricate of the same material as the liner. All baffle supports and brackets to be non-metallic. Baffle designs which permit close off of all slots are not acceptable.
- G. Work Surfaces: Molded epoxy resin 1-1/4 inches thick surface, dished 1/4 inch to contain spills. Refer to Section 123553
- H. Sinks: Where indicated on the drawings provide epoxy resin cup sinks as specified in Section 123553.
- I. Service Fixtures and Piping:
1. Factory pre-pipe hoods compliant to all state and local codes with services indicated on the drawings, to a point of connection 2 inches above hood roof. Provide, per Division 22 the piping material and installation of each service type. Pressure test all pre-piped lines in the factory.
 2. Provide service fixtures within fume hoods with color coded, acid and solvent resistant plastic coating, applied over fine sandblasted surface, properly cleaned then sprayed and baked three times. With a minimum coating thickness of 6 mil.
 3. Control Valves: Straight or 45 degree angle mounted fixtures on the front panel of the fume hood. Provide panel mounted or rod-type control valves with a threaded collar to hold the valve in place.
 4. Color coding of hood interior service fixtures and remote-control valves as specified for Laboratory Service Fixtures in Section 123553.
 5. On fume hoods with pre-punched service fixture holes, provide metal or plastic plugs in color to match fume hood, for all unused holes.
- J. Electrical:

1. Factory install receptacles, lighting, electrical fixtures and wiring in accordance with all applicable state and local codes and Division 26 specifications. Terminate wiring in a single service junction box on top of fume hood roof for in-the-field point of connection. All electrical fixtures shall be UL listed and labeled.
 2. Wiring: Minimum #12 copper, type THHN/THWN insulation. Wire color coding shall be black for current carrying conductors, white for neutral conductors and green for ground conductors.
 3. Conduit: Unless noted or required otherwise, ½ inch flexible metal or PVC conduit. Secure conduit to superstructure framework with conduit clamps. Conduit to light fixture to have a pigtail for ease of lamp maintenance.
 4. Receptacles: Provide each hood with the receptacle quantities as follows:
 - a. For 48 inch wide hoods: Provide one duplex receptacle at each side post near the bottom. Provide one circuit per hood assembly.
 - b. For 60 inch wide and greater hoods: Provide two duplex receptacles at each side post near the bottom. Receptacles on each side shall be wired alternately. Provide two circuits per hood assembly.
 - c. Provide grounding wire to all under-counter flammable storage cabinets.
 - d. Receptacle: NEMA-5-20R, three wire grounding type receptacles rated at 120 VAC at 20 AMP with Ground Fault Interruption, Gray in color with stainless steel brushed finish flush face plate. Install receptacles with the ground outlet above the power slots. Label each receptacle with the associated panel and circuit number.
 5. Lighting:
 - a. Fixture: LED, UL listed light fixture with 15 intensity adjustment levels and 3 color options installed on exterior of fume hood roof. Provide light fixture isolated from the hood interior by 1/4 inch thick laminated safety glass cemented and sealed to the hood roof. The lighting shall be serviceable from outside the fume hood interior. Color temperature of fume hood lighting to match color temperature for general room lighting.
 - b. Illumination: Minimum 80 foot candle at the full intensity setting at the worksurface.
 - c. Light Switch: Toggle type, single pole 120 VAC, 20 AMP, Gray in color with stainless steel brushed finished flush face plate. Mount on left side of fume hood side post
- K. Exhaust Outlet:
1. Rectangular or round bell mouth collar; 18 gage thick, Type 316 stainless steel.
 2. For hoods with rectangular duct collars, provide exhaust duct transition from the hood rectangular exhaust collar to the building exhaust system round duct connection. Round duct size as indicated in the Fume Hood schedule. Contractor shall coordinate between trades. Fabricate transition of the same material as the exhaust outlet.
- L. Fume Hood Signage:
1. Operation Instructions: Provide a permanent acid resistant decal or plate attached to fume hood exterior with condensed information covering recommended locations for apparatus and accessories, baffle settings, use of sash, and recommended safe operating procedures.
 2. Vertical Sash Stop Decal: Provide an acid resistant decal as detailed on the Drawings. Exact location to be determined when the fume hood is balanced.
 3. Fume Hood Information/Certification Holder: Provide a 4 inch by 6 inch corrosion resistant metal or plastic frame attached to front face of fume hood exterior with plastic or glass glazing to contain a removable data card to identify hood and show hood characteristics and field test data.
- M. UL Label: Clearly visible label affixed to hood front identifying fume hood as UL Classified. List the UL file number for verification of UL Classification.
- N. Safety Monitor/Alarm System:
1. Variable volume hoods: Equip each fume hood with a velocity control and safety alarm unit which is provided under Division 23. Provide factory cut outs in the front of the hood for field mounting of the unit. Coordinate location and size of cut out with Division 23. Connection of control and safety alarm unit to sensors and control valves under Division 23.

2.4 ACCESSIBLE BENCH TOP CHEMICAL FUME HOODS

- A. Accessible bench top chemical fume hoods shall be as detailed on the Drawings and as described under Article 2.4, Benchtop Chemical Fume Hoods, unless modified under this Article.
- B. Service Fixtures: Mount on fume hood side posts. Top-most service fixture handle to be no higher than 48 inches above finished floor. Fixture outlet within fume hood to be within 20 inches of the front face of the fume hood.
 - 1. Service fixture handles exceeding 48 inch reach range to be located in cabinet apron below fume hood with those services pre-piped between the handle and the outlet.
- C. Light Switch: Mount on fume hood side post no higher than 48 inches above finished floor.

2.5 METAL FINISH FOR FUME HOOD

- A. Refer to Section 123553.

2.6 SOURCE QUALITY CONTROL TESTING OF EPOXY RESIN WORK SURFACE

- A. Refer to Section 123553.

2.7 SOURCE QUALITY CONTROL TESTING OF POLY RESIN LINER

- A. Test Procedure:
 - 1. Test Number 1 - Spills and Splashes:
 - a. Suspend in a vertical plane a 42 inch horizontal by 12 inch vertical panel divided into 3/4 inch wide vertical columns.
 - b. Apply 5 drops of each reagent listed with an eye dropper.
 - c. Apply liquid reagents at top of panel and allow to flow down full panel height. "CAUTION! Flush away any reagent drops."
 - 2. Test Number 2 - Fumes and Gases:
 - a. Divide 24 inch by 12 inch panel into 2 inch squares.
 - b. Place 25 milliliters of reagent into 100 milliliter beakers and position panel over beaker tops in the proper sequence. Note: Beaker pouring lip permits atmospheric oxygen to enter and participate in the reaction of the reagent fumes.
 - 3. After 24 hours remove panel, flush with water, clean with naphtha and detergent, rinse, wipe dry and evaluate.
- B. Evaluation ratings: Change in surface finish and function shall be described by the following ratings:
 - 1. No Effect: No detectable change in surface material.
 - 2. Excellent: Slight detectable change in color or gloss, but no change to the function or life of the work surface material.
 - 3. Good: Clearly discernible change in color or gloss, but no significant impairment of work surface function or life.
 - 4. Fair: Objectionable change in appearance due to surface discoloration or etch, possibly resulting in deterioration of function over an extended period.
 - 5. Failure: Pitting, cratering or erosion of work surface material; obvious and significant deterioration.
- C. Test Results: Submit a report of the test results. The results shall be equal to or better than the following:

Reagent List	Test1	Test 2
Concentrations by Weight	Rating Spills	Fumes
Sodium Hydroxide	No Effect	No Effect

Sodium Hydroxide, 40%	No Effect	No Effect
Sodium Hydroxide, 20 percent	No Effect	No Effect
Sodium Hydroxide, 10 percent	No Effect	No Effect
Ammonium Hydroxide, 28 percent	No Effect	No Effect
Methylene Chloride	No Effect	No Effect
Chloroform	No Effect	No Effect
Carbon Tetrachloride	No Effect	No Effect
Monochlorobenzene	No Effect	No Effect
Tincture of Iodine	No Effect	Good
Methyl Alcohol	No Effect	No Effect
Ethyl Alcohol	No Effect	No Effect
Butyl Alcohol	No Effect	No Effect
Phenol, 85 percent	No Effect	Excellent
Cresol	No Effect	No Effect
Sodium Sulfide	No Effect	No Effect
Furfural	Excellent	Excellent
Dioxane	No Effect	No Effect
Zinc Chloride	No Effect	Excellent
Benzene	No Effect	No Effect
Toluene	No Effect	No Effect
Xylene	No Effect	No Effect
Gasoline	No Effect	No Effect
Naphthalene	No Effect	No Effect
Methylethyl Ketone	No Effect	No Effect
Acetone	No Effect	No Effect
Ethyl Acetate	No Effect	No Effect
Amyl Acetate	No Effect	No Effect
Ethyl Ether	No Effect	No Effect
Silver Nitrate, 10 percent	Excellent	Excellent
Dimethylformamide	Excellent	Excellent
Formaldehyde, 37 percent	No Effect	No Effect
Formic Acid, 88 percent	No Effect	Excellent
Acetic Acid, Glacial	No Effect	No Effect
Dichloroacetic Acid	No Effect	Excellent
Chromic Acid, 60 percent	No Effect	No Effect
Phosphoric Acid, 85 percent	No Effect	No Effect
Sulfuric Acid, 33 percent	No Effect	Excellent
Sulfuric Acid, 77 percent	No Effect	No Effect
Sulfuric Acid, 93 percent	No Effect	No Effect
Hydrogen Peroxide, 30 percent	No Effect	No Effect
Acid Dichromate	No Effect	No Effect
Nitric Acid, 20 percent	No Effect	Excellent
Nitric Acid, 30 percent	No Effect	No Effect
40 & 47 Equal Parts	No Effect	Good
Nitric Acid, 70 percent	No Effect	Good
Hydrofluoric Acid, 48 percent	No Effect	Excellent
Hydrochloric Acid, 37 percent	No Effect	Excellent

2.8 SOURCE QUALITY CONTROL TESTING OF FUME HOODS

- A. Submit a test report, for each type and size of hood, for the standard product previously tested, if the product is identical to equipment being provided for this project.
- B. Conduct an evaluation of standard product in the manufacturer's test facility in accordance with the method prescribed in ANSI/ASHRAE 110 latest edition. Provide test results for both the standard and modified tests.

- C. Hoods: Achieve a rating of 4.0 AM 0.05 with 4.0 being the tracer gas release rate in liters per minute, AM identifying an "as manufactured" test, and 0.05 indicating the maximum level of tracer gas, in parts per million, in the breathing zone.

2.9 SOURCE TESTING OF FUME HOOD SOUND LEVELS

- A. Provide the following historic certified sound test data for each size and type of fume hood.
- B. Background sound pressure level readings for the test facility with exhaust system operating but without connection to the fume hood.
- C. A second set of readings recorded with the fume hood connected and operating and the sensor located 36 inches in front of the sash assembly.
- D. Certified report: Octave band sound pressure level, Db re 20 micro Pa in the 31.5 to 8,000 Hertz frequency range, for the fume hood operating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Section 123553.

3.2 INSTALLATION

- A. Refer to Section 123553 and as modified below.
- B. Install fume hoods and equipment in accordance with manufacturer's instructions.
- C. Install equipment plumb, square, and straight with no distortion and securely anchored as required.
- D. Secure work surfaces to casework and equipment components with material and procedures recommended by the manufacturer.

3.3 FIELD QUALITY CONTROL TESTING OF FUME HOODS

- A. Refer to Section 123553 and as modified below.
- B. All Article numbers referenced below refer to the latest edition of ANSI/ASHRAE 110.
- C. Fume Hood Testing Companies:
 - 1. B & V Testing, Inc.
 - 2. Exposure Control Technologies, Inc.
- D. Technical Safety Services, Inc.
 - 1. Testing Requirements:
 - 2. Commission each fume hood in accordance with the test procedures prescribed in American National Standard ANSI/ASHRAE 110 latest edition.
 - 3. The fume hood commissioning agent: A third party and not a representative of the manufacturer or installation contractor.
 - 4. Provide the Owner's Representative two weeks prior notice of the testing start date.
- E. Testing Conditions:

1. Conduct tests under conditions as specified under Article 5.1 and 5.2.
 2. Commence fume hood commissioning immediately after the final Test and Balance Report has been approved and before the Owner has occupied the laboratory.
 3. Verify that the building makeup air system is in operation, the doors and windows are in normal operating position, and that all other hoods and exhaust devices are operating at design conditions.
 4. Correct any unsafe conditions disclosed by these tests before request of test procedures.
- F. Instrumentation and Equipment: Employ instrumentation and equipment as specified under Article 4.
- G. Face Velocity Measurement Test: Provide face velocity measurements as outlined under Article 6.
- H. Flow Visualization Test:
1. Conduct both Local Visualization Challenge and Large Volume Visualization Challenge in accordance with Articles 7.3 and 7.4 respectively.
 2. If there is visible smoke flow out of the front of the hood, the hood fails the test.
- I. Tracer Gas Test:
1. Provide a tracer gas test for each fume hood in accordance with the procedures specified under Article 8.
 2. Tracer gas shall be nitrous oxide. Sulfur hexafluoride is not allowed.
 3. Provide Sash Movement Containment Testing as indicated in Article 8.3
 4. Hoods shall achieve a rating of 4.0 AI 0.10, with 4.0 being the tracer gas release rate in liters per minute, AI identifying an "as installed" test, and 0.10 indicating the maximum level of tracer gas, in parts per million, in the breathing zone
- J. Test Reports: Provide a test report for each test for each hood. Include in report a record of all measurements and an indication of test "pass" or "failure".

3.4 ADJUSTING

- A. Refer to Section 123553 and as modified below.
- B. Adjust sash, fixtures, accessories and other moving or operating parts to function smoothly.

3.5 CLEANING AND PROTECTION

- A. Refer to Section 123553.

3.6 TRAINING

Upon completion of the installation of the fume hoods, manufacturer must conduct a training seminar for the Owner's users at the job site discussing proper operation of the fume hood, fume hood features and best use practices. Training session must be at least one hour in length, not including a question-and-answer session. Training session must be scheduled within 30 days on completion of the installationEND OF SECTION

SECTION 115317 – LABORATORY GLASSWARE WASHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glassware Washers - Undercounter
- B. Related Requirements:
 - 1. Division 22: Furnishing and installation of plumbing utilities and final connections to glassware washing equipment.
 - 2. Division 26: Furnishing and installation of electrical utilities and final connections to glassware washing equipment.

1.2 QUALITY ASSURANCE

- A. Single source responsibility: All systems and components, which comprise the washing equipment and accessories, shall be designed, fabricated and assembled by a single manufacturer.
- B. Manufacturer's qualifications: Modern plant with proper tools, dies, fixtures and skilled workers to produce high quality, glassware washing equipment and accessories, and shall meet the following minimum requirements:
 - 1. Ten years or more experience in manufacture of the type of equipment specified.
 - 2. Ten installations of equal or larger size and requirements.
- C. Installer's Qualifications: Factory trained and/or certified by the manufacturer.

1.3 REFERENCES

- A. The following industry, association and government codes and standards are cited in this Section. They shall be followed as applicable to the design, fabrication, assembly and testing of the specified equipment.
 - 1. American National Standards Institute (ANSI).
 - 2. American Society for Testing and Materials (ASTM).
 - 3. American Welding Society (AWS).
 - 4. Federal Occupational Safety and Health Act (OSHA).
 - 5. National Electric Code (NEC).
 - 6. National Electric Manufacturers Association (NEMA).
 - 7. National Fire Protection Association (NFPA).
 - 8. Underwriters Laboratory, Inc. (UL), for electrical safety and integrity.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products on the site in such a manner as to minimize the risk of damage, decay, deterioration or loss from theft.
- B. All products shall be delivered to the job site in manufacturer's original unopened containers, crates or protective wrappings with the manufacturer's name and address clearly labeled thereon.
- C. Schedule delivery of equipment so that spaces are sufficiently complete that equipment can be installed immediately following delivery.
- D. Accept products on site and inspect on arrival for damage.

- E. Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating.

1.5 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met.
 - 1. Windows and doors are installed and the building is secure and weathertight.
 - 2. Ceiling, overhead ductwork and lighting are installed.
 - 3. All painting is complete and flooring is installed.

1.6 ACTION SUBMITTALS

- A. Submittal Compliance Form: If Basis-of-Design products are provided, Submittal Compliance Form may be submitted in lieu of required Product Data submittal. Ensure compliance with requirements included in Section 013300 "Submittal Procedures."
- B. Product Data: Submit manufacturer's data for each item of equipment specified. Include dimensions, configurations, construction details, and attachments. Indicate location, size, and service requirements for each utility connection.
- C. Shop Drawings: Provide large scale plans and sections showing rough-in and anchor placements, clearances, and location of utilities for coordination with other trades.
 - 1. Indicate details for anchoring washers to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.

1.7 INFORMATIONAL SUBMITTALS

- A. Test Reports: Submit test reports verifying conformance to specified performance tests.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Manufacturer's operating and maintenance manuals.

1.9 COORDINATION

- A. The supplier/installer shall coordinate the installation of all products under this section and shall coordinate the installation and rough-in sizes and locations for all utilities required with the appropriate trades.

1.10 WARRANTY

- A. Manufacturer's Warranty: Furnish manufacturer's written material and labor warranty signed by an authorized representative using manufacturer's standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. "Defects" is defined to include but not limited to deterioration or failure to perform as required. Coverage of warranty includes but is not limited to the following:
 - 1. Warranty Period: Manufacturer shall warrant the products to be free from material and labor Defects for a period of 1 year from date of Substantial Completion.
- B. Installer's Warranty: Furnish installer's written workmanship warranty signed by an authorized representative using installer's standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. "Defects" is defined to include but not limited to deterioration or failure to perform as required.

1. Warranty Period: Installer shall warrant the installation to be free from workmanship Defects for a period of 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASSWARE WASHERS - UNDERCOUNTER

- A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
 1. Basis of Design: Labconco Corporation
- B. Acceptable Manufacturers/Fabricators and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures":
 1. Labconco Corporation; (Model: Flaskscrubber).
 2. Lancer, Getinge Group; (Model: 815 LX).
 3. Meile; (Model: PG 8583).
 4. Steris Corporation; Model: Reliance 100, 100LS or 100XLS.
- C. Size: As scheduled on the drawings.
- D. Service Requirements: As scheduled on the drawings.
- E. Arrangement:
 1. Cabinet: Fully enclosed cabinet. Constructed of Type 304 stainless steel, 20 gage thick, welded and polished to a Number 4 or 2B finish. Provide access panels on front of washer for service to all piping, valves, electrical components, and wiring.
 2. Undercounter or freestanding units: Door facing, front finishing panels and complete enclosure.
- F. Construction:
 1. Washing Chamber: Double-walled insulated construction of Type 304, 20 gage thick, welded stainless steel.
 2. Door: Provide with clear tempered safety glass view window. If vertical sliding provide counterbalance to remain at any height. Provide with cable safety latch to prevent door from falling in case door cable breaks.
 3. Spray System: Provide with rotary or linear spray system.
 4. Loading Shelves: Provide with a minimum of 2 loading shelves with the ability to remove a portion of the shelving for process of small, medium and large glassware simultaneously.
 5. Debris Screen: Provide stainless steel screens in bottom of sump to prevent debris from entering pump and piping system.
 6. Dual pump system: Separate pumps for drain and fill water to eliminate cross-contamination. System fills with clean water during drain to flush out washer before clean water is added
 7. Treatment Pump: Peristaltic type to automatically dispense a selected amount of liquid chemical into the chamber sump. Provide 3 pumps for dispensing of different chemicals.
 8. Internal Light: Provide flood light with explosion and vaporproof enclosure.
 9. Utility Services: Interpipe and interwire unit so that only one connection is required for each service or utility.
 10. Provide with seismic tie-down kit.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify equipment rough-in before proceeding with the work in this section.
- B. Coordinate with other trades for the proper and correct installation of plumbing and electrical rough-in, and structural backing for items attached to walls required for the installation of products in this section.
- C. Examine surfaces and conditions to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.2 INSTALLATION

- A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to the following, unless otherwise specified:
 - 1. Respective manufacturer/fabricator's written installation instructions.
 - 2. Accepted submittals.
 - 3. Contract Documents.
- B. Deliver to job site, uncrate, place in location, and assemble all equipment specified herein. Remove all debris and crating materials.
- C. Install equipment in strict accordance with the manufacturer's recommendations, including maintaining recommended operating and servicing clearances.
- D. Provide shutoff valves in all utility supply piping to the units.
- E. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
- F. Anchor equipment securely in place with a seismic tie-down kit, in accordance with design calculations and requirements..

3.3 SUPERVISION AND STARTUP

- A. Provide the services of the manufacturer's factory trained field representative to inspect and provide written approval of the installation.
- B. Include the services of the manufacturer's representative to start up and test the equipment. The manufacturer shall certify in writing that the equipment is operating according to specifications.

3.4 CLEANUP, MAINTENANCE, ADJUSTING AND DEMONSTRATION

- A. At completion, clean all surfaces thoroughly using no cleaners, which will harm adjacent surfaces.
- B. Protect all equipment and surfaces from damage and replace all damaged items.
- C. Adjust operating equipment to efficient operation for its intended use, and as required by the manufacturer.
- D. Include the services of the manufacturer's representative to instruct the Owner's operating personnel in the proper care and operation of the units.

3.5 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent damage to equipment from exposure to other construction activity

END OF SECTION

SECTION 115319 – LABORATORY STERILIZERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Small Steam Sterilizers
 - 2. Integral Electric Clean Steam Generator
- B. Related Requirements:
 - 1. Division 22: Furnishing and installation of plumbing utilities and final connections to sterilizer equipment.
 - 2. Division 26: Furnishing and installation of electrical utilities and final connections to sterilizer equipment.

1.2 QUALITY ASSURANCE

- A. Single source responsibility: All systems and components, which comprise the sterilizer equipment and accessories, shall be designed, fabricated and assembled by a single manufacturer.
- B. Manufacturer's qualifications: Modern plant with proper tools, dies, fixtures and skilled workers to produce high quality, sterilizer equipment and accessories, and shall meet the following minimum requirements:
 - 1. Ten years or more experience in manufacture of the type of equipment specified.
 - 2. Ten installations of equal or larger size and requirements.
- C. Installer's Qualifications: Factory trained and/or certified by the manufacturer.

1.3 REFERENCES

- A. The following industry, association and government codes and standards are cited in this Section. They shall be followed as applicable to the design, fabrication, assembly and testing of the specified equipment.
 - 1. American National Standards Institute (ANSI).
 - 2. American Society for Testing and Materials (ASTM).
 - 3. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section IX.
 - 4. American Society of Mechanical Engineers (ASME), Unified Pressure Vessel Code, Section VIII.
 - 5. American Welding Society (AWS).
 - 6. Federal Occupational Safety and Health Act (OSHA).
 - 7. National Electric Code (NEC).
 - 8. National Electric Manufacturers Association (NEMA).
 - 9. National Fire Protection Association (NFPA).
 - 10. Underwriters Laboratory, Inc. (UL), for electrical safety and integrity.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products on the site in such a manner as to minimize the risk of damage, decay, deterioration or loss from theft.
- B. All products shall be delivered to the job site in manufacturer's original unopened containers, crates or protective wrappings with the manufacturer's name and address clearly labeled thereon.
- C. Schedule delivery of equipment so that spaces are sufficiently complete that equipment can be installed immediately following delivery.

- D. Accept products on site and inspect on arrival for damage.
- E. Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating.

1.5 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met.
 - 1. Windows and doors are installed and the building is secure and weathertight.
 - 2. Ceiling, overhead ductwork and lighting are installed.
 - 3. All painting is complete and flooring is installed.

1.6 ACTION SUBMITTALS

- A. Submittal Compliance Form: If Basis-of-Design products are provided, Submittal Compliance Form may be submitted in lieu of required Product Data submittal. Ensure compliance with requirements included in Section 013300 "Submittal Procedures."
- B. Product Data: Submit manufacturer's data for each item of equipment specified. Include dimensions, configurations, construction details, and attachments. Indicate location, size, and service requirements for each utility connection.
- C. Shop Drawings: Provide large scale plans and sections showing rough-in and anchor placements, clearances, and location of utilities for coordination with other trades.
 - 1. Indicate details for anchoring sterilizers to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.

1.7 INFORMATIONAL SUBMITTALS

- A. Test Reports: Submit test reports verifying conformance to specified performance tests.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Manufacturer's operating and maintenance manuals.

1.9 COORDINATION

- A. The supplier/installer shall coordinate the installation of all products under this section and shall coordinate the installation and rough-in sizes and locations for all utilities required with the appropriate trades.

1.10 WARRANTY

- A. Manufacturer's Warranty: Furnish manufacturer's written material and labor warranty signed by an authorized representative using manufacturer's standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. "Defects" is defined to include but not limited to deterioration or failure to perform as required. Coverage of warranty includes but is not limited to the following:
 - 1. Warranty Period:
 - a. Manufacturer shall warrant the products to be free from material and labor Defects for a period of 1 year from date of Substantial Completion.
 - b. Provide 2 year warranty on door gaskets.

- B. Installer's Warranty: Furnish installer's written workmanship warranty signed by an authorized representative using installer's standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. "Defects" is defined to include but not limited to deterioration or failure to perform as required.
 - 1. Warranty Period: Installer shall warrant the installation to be free from workmanship Defects for a period of 1 year from date of Substantial Completion.
- C. For ASME stamped sterilizer pressure vessels, provide a 15 year warranty against structural failure. Warranty shall start at completion of installation and startup.

PART 2 - PRODUCTS

2.1 SMALL STEAM STERILIZERS

- A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
 - 1. Basis of Design: Consolidated.
- B. Acceptable Manufacturers/Fabricators and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures":
 - 1. Consolidated; Model: SR-24A.
 - 2. Primus; Model: Model A.
 - 3. Beta Star, R-V Industries Inc.; Model LSII.
- C. Size:
 - 1. As scheduled on the Drawings.
- D. Type:
 - 1. Prevacuum: Sterilization of porous and non-porous heat and moisture-stable goods, sterilization of liquids and media in borosilicate glass containers with vented closures, and decontamination of supplies after laboratory procedures. Sterilizers shall be equipped with prevacuum, gravity, liquid, leak test, and daily air removal test cycles.
- E. Construction:
 - 1. Chamber and Jacket: Type 316L stainless steel chamber. Welded pressure vessel construction in accordance with the requirements of ASME Code, Section VIII for unfired pressure vessels. Design for a minimum working pressure of 45 psig and full vacuum. The vessel shall be stamped and a signed copy of the U-1 form furnished. Provide vessel with an ASME approved and stamped safety valve.
 - 2. Insulation: Minimum 1 inch thick foil backed glass fiber to cover the jacket of the assembly.
 - 3. Doors: Type 316L stainless steel. Provide with self-aligning gasket for a positive seal when the door is closed. Design to lock automatically when chamber pressure is positive and to unlock only when pressure is reduced to approximately atmospheric.
 - 4. Support Structure: Provide with height adjustable steel stand with floor pads and leveling screws. Stand to have corrosion resistant coating.
 - 5. Provide with seismic tie-down kit.
- F. Enclosure:

1. Facia and enclosure material: Type 304 stainless steel polished to a Number 4 finish; minimum 16 gage.
2. Cabinet enclosed units: Door facing, front finishing panels and complete enclosure.
3. Provide service access panels in all enclosed units.
4. Door configuration shall be as indicated on the Drawings.

G. Control System:

1. The control system consists of the Allen-Bradley CompactLogix Programmable Logic Controller (PLC) with an Allen-Bradley Operator Interface on the load side to monitor and control all phases of the sterilizer operation. System shall be non-proprietary.
2. Provide control panel with touch pad controls. Display shall indicate sterilizer status, time of day, cycle times, temperature, pressure, and any warnings or instructional message.
3. Mount control panel on operating end of unit and provide front panel service access to PLC control boards and associated electronics.
4. The control system shall be factory programmed with standard sterilizing cycles. Each cycle shall be field adjustable, through cycle selector and value change touch pads, to meet specific processing requirements. The system shall provide the operator with the capability to change cycle parameters from the control panel. Control will shut off the steam to the jacket after the unit has sat idle for a specified period as determined and programmed by the user.
5. Provide control system with a printer to continuously record on a strip chart cycle identification, cycle progression, selected parameters, date, time, chamber temperature, chamber pressure, alarms, and diagnostics.
6. Provide the following cycle safeguards:
 - a. Cycle inoperative unless doors are closed and locked.
 - b. Rejection of incorrect cycle parameters.
7. Automatic condensing of chamber steam and disposal of condensate to waste. Condensate discharge temperature shall not exceed 140 degrees Fahrenheit. Control system shall include a security access code to prevent cycles and cycle values from being changed by unauthorized personnel.
8. Provide the control system with memory storage or battery backup to protect all cycle memory.

H. Safety Features:

1. Control lockout switch: Provide on chamber door to prevent cycle from starting until door is closed and seal is energized.
2. Chamber float switch: Install to abort cycle and vent chamber if excessive condensate is detected in the chamber.
3. Pressure relief valve: Provide to limit the internal pressure from exceeding the pressure rating of the vessel. Pipe from outlet of valve down to floor sink with proper air gap.

I. Piping:

1. Terminate all connections within the confines of the sterilizer, accessible from the front and/or side of the unit.
2. Steam Piping: Provide with shutoff valve, steam strainer, pressure regulator, and control valves.
3. Water Piping: Provide with shutoff and control valves.
4. For units requiring compressed air for operation of door, door seals, or controls, if compressed air is not available then provide integral air compressor with the unit.
5. Collect steam effluent and hold it in a cooling tank to reduce the amount of water required to cool the effluent.

J. Options:

1. Automatic Jacket Blowdown: Provide exhaust from jacket to prevent liquid loads from boiling over.
2. Liquid Ring Vacuum Pump: Include integral, single stage, liquid ring vacuum pump for chamber evacuation and a minimum of 35 percent water savings.

3. Load Probe: Provide temperature probe permitting placement in the load to be sterilized. Sterilization cycle time based on load temperature. Provide read out for the non-control side, monitoring temperature of the load during a cycle.
- K. Accessories:
1. For Small Sterilizer Units: Provide rack with 2 shelves constructed of stainless steel or monel metal, rack to match size of chamber.
- L. Integral Electric Clean Steam Generator:
1. Provide an integral electrically powered clean steam generator OR an integral steam powered clean steam generator.
 2. Electrical Power: As scheduled on the drawings.
 3. Control Power: As scheduled on the drawings.
 4. Construct of carbon steel in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section 1, Miniature Boilers.
 5. Include a feed water pump powered by a continuous duty 3-phase motor.
 6. Feed water piping shall include shutoff valve, strainer and vacuum breaker.
 7. Steam generator and feed water pump shall operate automatically whenever the sterilizer is on. Interface generator with sterilizer flood fail safe controls.
 8. Provide unit with operating and safety controls, including low water cutoff, boiler feed water valve, and ASME approved safety valve.
 9. Provide an automatic blowdown/flush that incorporates a motorized ball shutoff valve that automatically uses steam pressure to minimize mineral accumulation in the steam boiler. Provide with a seven-day timer that allows the user to select a time each day to schedule the blowdown/flush function.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify equipment rough-in before proceeding with the work in this section.
- B. Coordinate with other trades for the proper and correct installation of plumbing and electrical rough-in, and structural backing for items attached to walls required for the installation of products in this section.
- C. Examine surfaces and conditions to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.2 INSTALLATION

- A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to the following, unless otherwise specified:
 1. Respective manufacturer/fabricator's written installation instructions.
 2. Accepted submittals.
 3. Contract Documents.
- B. Deliver to job site, uncrate, place in location, and assemble all equipment specified herein. Remove all debris and crating materials.
- C. Install equipment in strict accordance with the manufacturer's recommendations, including maintaining recommended operating and servicing clearances.
- D. Provide shutoff valves in all utility supply piping to the units.

- E. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
- F. Anchor equipment securely in place with a seismic tie-down kit, in accordance with design calculations and requirements..

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Include the services of the manufacturer's factory trained field representative to inspect and provide written approval of installation.
- B. Owner's Testing Agency Field Service: Include the services of the manufacturer's representative to start up and test the equipment, and to instruct the Owner or the Owner's operating personnel in the proper care and operation of the unit. The manufacturer shall certify in writing that the equipment is operating according to specifications.

3.4 SUPERVISION AND STARTUP

- A. Provide the services of the manufacturer's factory trained field representative to inspect and provide written approval of the installation.
- B. Include the services of the manufacturer's representative to start up and test the equipment. The manufacturer shall certify in writing that the equipment is operating according to specifications.

3.5 CLEANUP, MAINTENANCE, ADJUSTING AND DEMONSTRATION

- A. At completion, clean all surfaces thoroughly using no cleaners, which will harm adjacent surfaces.
- B. Protect all equipment and surfaces from damage and replace all damaged items.
- C. Adjust operating equipment to efficient operation for its intended use, and as required by the manufacturer.
- D. Include the services of the manufacturer's representative to instruct the Owner's operating personnel in the proper care and operation of the units.

3.6 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent damage to equipment from exposure to other construction activity

END OF SECTION

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Manually operated shades; single rollers, for sunscreen shades. (WS-1)
 2. Manually operated shades; double rollers, for sunscreen and blackout shades. (WS-2)
 3. Electrically operated motorized shades; double rollers, for sunscreen and blackout shades. (WS-3)

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- C. Samples for Verification: For each type of roller shade.
1. Shadeband Material: Not less than 10 inches square. Mark interior face of material if applicable.
- D. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer for Roller Shade System - Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.
- B. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.
- C. ShadeCloth Anti-Microbial Characteristics: 'No Growth' per ASTM G 21 results for fungi ATCC9642, ATCC 9644, ATCC9645.
- D. Requirements for Electronic Hardware, Controls, and Switches: Roller shade hardware, shade fabric, EDU, and all related controls shall be furnished and installed as a complete two-way communicating system and assembly.
- E. Provide the following upon request:
1. Qualification Data: For Installer.
 2. Product Certificates: For each type of shadeband material.
 3. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.7 WARRANTY

- A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating twenty-five year warranty.
- B. Shadecloth: Manufacturer's standard warranty period as indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.
- B. Basis-of-Design ManufacturerProduct: Subject to compliance with requirements, provide listed products by the following:
 - 1. MechoShade Systems, Inc., or comparable products by one of the following:
 - a. Draper Inc.
 - b. Lutron Electronics Co., Inc.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Basis-of-Design Product (WS-1): Subject to compliance with requirements, provide the following:
 - 1. MechoShade Systems, Inc.; Mecho/5 Manual Shade System, or approved equal.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Stainless steel.
 - a. Limit Stops: Provide upper and lower ball stops.
 - b. Chain-Retainer Type: Clip, jamb mount, anti-ligature.
 - 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
 - a. Provide for shadebands that weigh more than 5 lb or for shades as recommended by manufacturer, whichever criterion is more stringent.

- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Shadebands:
 - 1. Shadeband Material: Light-filtering fabric.
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- F. Installation Accessories:
 - 1. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Provide pocket with lip at lower edge to support acoustical ceiling panel.

2.3 MANUALLY OPERATED SHADES WITH DOUBLE ROLLERS

- A. Basis-of-Design Product (WS-2): Subject to compliance with requirements, provide the following:
 - 1. MechoShade Systems, Inc.; Mecho/5 Manual Shade System, or approved equal.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Stainless steel.
 - a. Limit Stops: Provide upper and lower ball stops.
 - b. Chain-Retainer Type: Clip, jamb mount, anti-ligature.
 - 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
 - a. Provide for shadebands that weigh more than 5 lb (4.5 kg) or for shades as recommended by manufacturer, whichever criterion is more stringent.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. Double-Roller Mounting Configuration: Offset, outside roller over and inside roller under.
 - 2. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- F. Inside Shadebands:
 - 1. Shadeband Material: Light-filtering fabric.
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

- a. Type: Enclosed in sealed pocket of shadeband material.
- G. Outside Shadebands:
 - 1. Shadeband Material: Light-blocking fabric.
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
- H. Installation Accessories:
 - 1. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Provide pocket with lip at lower edge to support acoustical ceiling panel or gypsum board to suit condition.
 - 2. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
 - 3. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
 - 4. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 MOTOR-OPERATED SHADES WITH DOUBLE ROLLERS

- A. Basis-of-Design Product (WS-3): Subject to compliance with requirements, provide the following:
 - 1. MechoShade Systems, Inc.; ElectroShade Electric Shade System, or approved equal.
- B. Description: Motor-operated fabric window shades.
 - 1. Shade Type: Double Roller; configured for light-filtering and room-darkening shades in one opening
 - a. Light-Filtering Fabric: Room-side of opening.
 - b. Room-Darkening Fabric: Glass-side of opening.
 - 2. Drop Position: Regular roll, offset
 - 3. Mounting: Recessed in prewired ceiling pocket, unless otherwise indicated.
 - 4. Size: As required by individual window opening size.
- C. Motorized Operating Systems: Provide factory-assembled, shade-operator systems of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
 - 1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Electric Motor: Manufacturer's standard tubular, enclosed in rollers.
 - a. Electrical Characteristics: 110-V ac.
 - 3. Remote Control: Electric controls with NEMA ICS6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
 - a. Keyed Control Station: Keyed, maintained -contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.
 - 4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.

5. Limit Switches: Adjustable switches, interlocked with motor controls and set to stop shade movement automatically at fully raised and fully lowered positions.
- D. Inside Shadebands:
1. Shadeband Material: Light-filtering fabric.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
- E. Outside Shadebands:
1. Shadeband Material: Light-blocking fabric.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
- F. Accessories:
1. Recessed prewired ceiling pocket.
 2. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
 3. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
 - a. Room-Darkening Shades: Provide a slot in bottom bar with wool-pile light seal.
 4. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.5 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
1. Source: Roller shade manufacturer.
 2. Basis-of-Design: As indicated on Finish Schedule on Drawings. Weave containing no chemical flame retardant, visually transparent.
 - a. Warranty Period: 10-years.
 3. Color: As indicated; refer to Finish Schedule on Drawings.
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
1. Source: Roller shade manufacturer.
 2. Basis-of-Design: As indicated on Finish Schedule on Drawings.
 - a. Features: Washable, antistatic treatment.
 - b. Warranty Period: 10-years.
 3. Color: As indicated; refer to Finish Schedule on Drawings.
 4. Orientation on Shadeband: Up the bolt.

2.6 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F :
1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.

2.7 MOUNTING ACCESSORIES

- A. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - 1. Single Roller Brackets: Configured for light-filtering shades.
 - 2. Double Roller Brackets: Configured for light-filtering and room-darkening shades in one opening.
 - a. Light-Filtering Fabric: Room-side of opening.
 - b. Room-Darkening Fabric: Glass-side of opening.
 - 3. Multiple Shade Operation: Provide hardware as necessary to operate more than one shade using a single motor.
- B. Recessed Ceiling Pockets with Prewired Raceway:
 - 1. UL 325 listed, extruded aluminum shade-pocket for recess mounting in acoustical tile or drywall ceilings; size and configuration as indicated on Drawings.
 - a. Basis of Design: MecoShade Systems LLC; ElectroPocket
 - 1) Removable closure panel.
 - 2) Ceiling tile support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
- B. Roller Shade Locations: As indicated on Drawings.

3.3 ADJUSTING

- A. Adjust, align, and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION

SECTION 123553 - GENERAL REQUIREMENTS FOR LABORATORY / ARTS CASEWORK AND FUME HOODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes laboratory casework with supplementary items necessary to complete their installation.
 - 1. Manufacturers.
 - 2. Materials.
 - 3. Hardware.
 - 4. Under-counter Corrosive Storage Cabinets.
 - 5. Under-counter Flammable Storage Cabinets.
 - 6. Tables.
 - 7. Adjustable Shelving.
 - 8. Finishes.
 - 9. Work surfaces.
 - 10. Sinks.
 - 11. Laboratory Service Fixtures.
 - 12. Electrical Service Fixtures.
 - 13. Emergency Shower and Eye Wash Units.
 - 14. Gas Cylinder Restraints.
 - 15. Gas Cylinder Racks.

- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory casework and fume hoods.
 - 2. Section 096513 "Resilient Base and Accessories" for resilient base applied to floor mounted laboratory casework and fume hood base cabinets.
 - 3. Section 112183 "Photo Processing Sinks."
 - 4. Section 115313 "Laboratory Fume Hoods."
 - 5. Section 123553.13 "Stainless Steel Laboratory Casework."
 - 6. Section 123553.19 "Wood Laboratory / Arts Casework."
 - 7. Section 123553.26 "Solid Phenolic Resin Photography Casework"
 - 8. Division 22: Furnishing and installation of plumbing utilities and final connections.
 - 9. Division 23: Furnishing and installation of exhaust duct work and equipment, and final connections.
 - 10. Division 26: Furnishing and installation of electrical utilities and final connections.
 - 11. Division 27: Furnishing and installation of communication utilities and final connections.

1.2 REFERENCES

- A. American Hardboard Association (AHA)
 - 1. A135.4 – Basic Hardboard.

- B. Americans with Disabilities Act (ADA).

- C. American National Standards Institute (ANSI)
 - 1. ANSI A117.1 – Accessible and Useable Buildings and Facilities
 - 2. ANSI A208.1 – For Particleboard.
 - 3. ANSI A208.2 - For Medium Density Fiberboard.
 - 4. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.
 - 5. ANSI/HPVA HP-1 - For Hardwood and Decorative Plywood.

- D. American Society for Testing and Materials (ASTM).

1. ASTM A167-99 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
 2. ASTM A240 - Chromium and Chromium-nickel Stainless Steel Plate, Sheet, and Strip for pressure Vessels and General Applications.
 3. ASTM A1008 - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 4. ASTM B221/B221M – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
 5. ASTM B584 – Specification for Copper Alloy Sand Castings for General Applications.
 6. D543 – Practices for Evaluating the Resistance of Plastics to Chemical Reagents
 7. ASTM D570 - Water Absorption of Plastics.
 8. ASTM D635 - Rate of Burning and/or Extent and Time of Burning of Plastics in Horizontal Position.
 9. ASTM D638 - Tensile Properties of Plastic.
 10. ASTM D648 - Deflection Temperature of Plastic Under Flexural Load in the Edgewise Position.
 11. ASTM D695 - Compressive Properties of Rigid Plastics.
 12. ASTM D785 – Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
 13. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 14. ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.
- E. Business and Institutional Furniture Manufacturers Association (BIFMA).
- F. Factory Mutual (FM).
- G. Forest Stewardship Council (FSC).
- H. Leadership in Energy and Environmental Design (LEED).
- I. National Electrical Manufacturers Association (NEMA).
1. NEMA LD3 - High-Pressure Decorative Laminates.
- J. National Fire Protection Association (NFPA).
1. NFPA 30 - Flammable and Combustible Liquids Code.
 2. NFPA 45 – Standards on Fire Protection for Laboratories Using Chemicals
- K. Office of Safety and Health Administration (OSHA).
- L. United States Department of Commerce, National Institute of Standards and Technology
1. PS 1 – Construction and Industrial Plywood.
 2. PS 51 – Hardwood and Decorative Plywood
- M. Scientific Equipment and Furniture Association (SEFA).
1. SEFA Desk Reference.
- N. Underwriters Laboratories (UL).
- O. Woodwork Institute (WI).
- 1.3 PREINSTALLATION CONFERENCE**
- A. Before Work begins, conduct conference at Project site to comply with requirements of applicable Division 01 Sections.
1. Required Attendees:
 - a. Owner.

- b. Architect.
 - c. Contractor, including superintendent.
 - d. Installer, including project manager and supervisor.
 - e. Manufacturer/fabricator's qualified technical representative.
 - f. Installers of other construction interfaced with Work.
2. Minimum Agenda: Installer shall demonstrate understanding of the Work required by describing detailed procedures for preparing, installing, and cleaning the Work. Demonstration shall include, but not be limited to, following topics:
- a. Tour representative areas of Work, inspect and discuss condition of substrate, and other preparatory work performed by other trades.
 - b. Review Work requirements (Drawings, Specifications, and other Contract Documents).
 - c. Review required submittals, both completed and yet to be completed.
 - d. Review and finalize construction schedule related to Work and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - e. Review required inspection, testing, certifying, and material usage accounting procedures.
 - f. Review environmental conditions and procedures for coping with unfavorable conditions.
 - g. Resolve deviations or differences between Contract Documents and the manufacturer/fabricator's specifications.
3. Record discussions of conference, including decisions and agreements reached, and furnish copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.

1.4 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for lateral support of fume hoods, wall and tall cabinets.
- B. Coordinate installation of fume hoods with laboratory casework and other laboratory equipment.

1.5 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's data for each item of laboratory furnishings and equipment. Include component dimensions, configurations, construction details, joint details, and attachments. Indicate location, size, and service requirement for each utility connection.
- B. Sustainable Design Submittals:
 1. Environmental Product Declaration (EPD): For each product.
 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 3. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: Include the following:
 1. Location of assemblies in each room to include plans, elevations, sections, and attachment details for casework, fume hoods, canopy hoods, point exhausts and ceiling service panels. Include roughing-in information for mechanical, plumbing, and electrical connections.
 2. Details of construction.
 3. Details of connections between units and to adjacent work.
 4. Indicate details for anchoring laboratory casework and fume hoods to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.
 5. Show adjacent walls, doors, windows, other building components, laboratory casework, and other laboratory equipment. Indicate clearances from the above items
 6. Location and size of holes and cutouts.
 7. Dimensional locations for rough-in of mechanical and electrical services.

8. Molded epoxy resin tops jointing pattern.
9. Include coordinated dimensions for laboratory equipment specified in other Sections.

D. Samples:

1. Submit Samples which conform to specified requirements, including construction and finishes. Samples will be retained for comparison with Work fabricated and will be returned upon completion of the Contract.
2. Submit the following Samples for approval:
 - a. Casework: Metal finish, wood finish, service fixture finish, and work tops.
 - b. Fume Hoods: Exterior finishes, interior lining, and work tops.
 - c. One full size combination drawer and cupboard base cabinet with all hardware.

- E. Keying Schedule: Include room and cabinet index with each key set to unique designations that are coordinated with the Contract Documents.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Project Acceptance Document: Certification by the manufacturer that its product(s) are approved, acceptable, suitable for use in specific locations, for specific details, and for applications indicated, specified, or required, and that a warranty will be issued.
- B. Qualification Data: For manufacturer/fabricator, installer and professional engineer.
1. For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.
 2. Architect may waive submittal of qualification data for available manufacturers listed in this Section.
- C. Test Reports: Submit test reports verifying conformance to specified performance tests.
- D. Field Quality Control Reports: Written report of testing and inspection required by "Field Quality Control".

1.7 CLOSEOUT SUBMITTALS

- A. Furnish maintenance instructions and complete touchup kit for each type and color of laboratory paint finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged casework and fume hood finishes.
- B. Operation & Maintenance Manuals: Provide complete written instruction manuals outlining safe operating procedures, safety guidelines, and proper maintenance procedures for equipment and fume hoods.
- C. Warranty: Provide manufacturer's written warranty covering materials and installation (labor) stating obligations, remedies, limitations and exclusions.
- D. Receipts: Furnish receipts for keys and other loose items.

1.8 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide casework, work surfaces, laboratory furnishings, and accessories, all furnished by a single laboratory furniture company.
- B. Manufacturer/Fabricator Qualifications: Manufacturer/fabricator with not less than 10 years experience with successful production of products and systems similar to scope of this Project, with a record of successful in-service performance and completion of projects for a period of not less than 10 years, and with sufficient production capability, facilities, and personnel to produce required Work.

1. Modern plant with proper tools, dies, fixtures, and skilled production staff to produce high quality laboratory casework and equipment, and shall meet the following minimum requirements:
 - a. 10 years or more experience in manufacture of laboratory casework and equipment of type specified.
 - b. 10 installations of equal or larger size and requirements.
- C. Installer Qualifications:
 1. Experience: Installer with not less than 10 years experience in performing specified Work similar to scope of this Project, with a record of successful in-service performance and completion of projects for a period of not less than 10 years, and with sufficient production capability, facilities, and personnel to produce required Work.
 2. Supervision: Installer shall maintain a competent supervisor who is at Project during times specified Work is in progress, and, who is experienced in installing systems similar to type and scope required for Project.
 3. Manufacturer/Fabricator Acceptance: Installer shall be certified, approved, licensed, or acceptable to manufacturer/fabricator to install products.
- D. Manufacturer's Technical Representative Qualifications: Direct employee of technical services department of manufacturer with minimum of 10 years experience in providing recommendations, observations, evaluations, and problem diagnostics. Sales representatives are not acceptable.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Schedule delivery of casework and equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.
- B. Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating. Protect all work surfaces from damage throughout construction period. Do not allow standing on work surfaces during the construction period. Provide signage marked in large lettering that reads: "NO STANDING".

1.10 FIELD CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:
 1. Building areas requiring the installation of laboratory casework: Dry and unexposed to adverse weather conditions which may damage finished materials.
 2. The air conditioning or heating system: On and functioning in areas of casework installation to maintain the temperature between 60 and 85 degrees Fahrenheit with the relative humidity between 45 percent and 65 percent.
- B. Field Measurements: Where products and systems are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.11 SEQUENCING AND SCHEDULEING

- A. All overhead mechanical, electrical and plumbing rough-in work: Complete prior to laboratory casework deliveries.
- B. All mechanical, electrical and plumbing rough-in work required along walls and service islands, where lab furnishings are to be installed: Complete prior to delivery of materials.
- C. Walls and partitions must be in place and finished with at least the primer coat of paint. If finish painting is to take place after lab casework and furnishings installation, protect the casework and furnishings by covering and masking prior to commencement.

- D. All necessary wood or metal blocking must be installed within partitions prior to delivery of casework and furnishings.
- E. Overhead soffits and ceiling grid must be in place prior to casework installation.
- F. Overhead lighting must be installed and connected prior to casework installation.
- G. All flooring required to be placed under lab casework systems must be installed prior to lab casework material delivery.
- H. Concrete floors must be level within 1/8 inch of level per 10 foot run, nonaccumulative, when tested with a straight edge in any one direction.
- I. Wet operations to be performed must be complete prior to material deliveries.

1.12 WARRANTY

- A. **Manufacturer's Warranty:** Furnish manufacturer's written material and labor warranty signed by an authorized representative using manufacturer's standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. "Defects" is defined to include but not limited to deterioration or failure to perform as required.
 - 1. **Warranty Period:** Manufacturer shall warrant the products to be free from material and labor defects for a period of 1 year from date of operational acceptance by the Using Agency.
 - 2. Date of operational acceptance shall be after factory check, test and start-up services is complete, the unit is operating in a satisfactory manner, and the equipment has been satisfactorily commissioned by the Using Agency.
 - 3. The Using Agency will perform routine maintenance as described in the Manufacturers Standard Operation and Maintenance manuals during the warranty period. Using Agency performance shall in no way invalidate said warranties.
- B. **Installer's Warranty:** Furnish installer's written workmanship warranty signed by an authorized representative using installer's standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. "Defects" is defined to include but not limited to deterioration or failure to perform as required.
 - 1. **Warranty Period:** Installer shall warrant the installation to be free from workmanship defects for a period of 1 year from date of operational acceptance by the Using Agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. **Acceptable Manufacturers/Fabricators and Products:** Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures".
 - 1. CiF Lab Solutions.
 - 2. Diversified Casework.
 - 3. Kewaunee Scientific Corporation.
 - 4. ICI Scientific.
 - 5. Mott Manufacturing Limited.
 - 6. Air Master Systems Corporation.

- B. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
 - 1. Basis of Design: Kewaunee Scientific Corporation.
- C. Furnish and install casework, fume hoods, furnishings and equipment specified in the following sections by the same supplier.
 - 1. Section 112183 - Photo Processing Sinks
 - 2. Section 115300 - Miscellaneous Laboratory and Arts Equipment.
 - 3. Section 115313 - Laboratory Fume Hoods.
 - 4. Section 123553 - General Requirements for Laboratory and Arts Casework and Fume Hoods.
 - 5. Section 123553.13 - Stainless Steel Laboratory Casework.
 - 6. Section 123553.19 - Wood Laboratory Casework.
 - 7. Section 123553.26 - Solid Phenolic Resin Photography Casework

2.2 PERFORMANCE REQUIREMENTS

- A. Contract Documents Design Intent: Drawings and Specifications indicate design intent for products and systems and do not necessarily indicate or specify total Work required and shall not be construed as an engineered design. Furnish and install all Work required for a complete installation.
- B. Coordination of Contract Documents and Work:
 - 1. Product Variations: In the event of minor differences between products and systems of acceptable or available manufacturer/fabricators, Contractor shall notify Architect of such differences and resolve conflicts in a timely manner. Failure of Contractor to provide notification shall be construed as acceptance of conditions indicated, and changes caused by minor differences between products and Contract Documents shall be included in the Work at no additional cost to Owner.
 - 2. Allowable Adjustments: Minor dimension and profile adjustments may be made in interest of fabrication or erection methods or techniques or ability to satisfy design intent, provided design intent is maintained as determined by Architect. Proposed deviations shall include a detailed analysis of impact to adjacent substrates or other building systems, including related design or construction cost impacts. If accepted by Architect, deviations causing changes in materials, constructability, substrates, or conditions shall be included in the Work at no additional cost to Owner.

2.3 CASEWORK, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Certified Wood: Wood products shall comply with requirements of ASTM D7612-10 (FSC, SFI, ATSM, CSA or PEFC certifications are acceptable).

2.4 MATERIALS

- A. Wood:
 - 1. Composite Wood Products:
 - a. Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
 - 2. Definition of cabinet components by surface visibility.
 - a. Exposed Exterior Surfaces: Defined as all exterior surfaces exposed to view:

- 1) All surfaces visible when doors and drawers are closed, including knee spaces.
 - 2) All sides of cabinets that abut other casework but will become visible when the casework is reconfigured.
 - 3) All exterior surfaces of suspended casework.
 - 4) All exterior surfaces of mobile casework.
 - 5) Underside of cabinet bottoms 42 inches or more above finished floor, including cabinet bottoms behind light valances and the bottom edge of light valances.
 - 6) Cabinet tops under 80 inches above finished floor, or if 80 inches and over and visible from an upper floor or building level after installation.
 - 7) Visible front edges of stretchers, ends, dividers, tops, bottoms, shelves, and hanging stile.
 - 8) Visible portions of bottoms, tops, and ends in front of sliding doors.
 - 9) Sloping tops of cabinets.
 - 10) Visible portions of cabinets after fixed appliances are installed.
- b. Exposed Interior Surfaces: Defined as all interior surfaces exposed to view in open casework or behind transparent doors:
- 1) Fixed, adjustable and pull-out shelves, including edgebanding of all sides.
 - 2) Dividers and partitions.
 - 3) Interior face of ends (sides), backs, and bottoms, including Interior surfaces of cabinet top members 36 inches or more above the finished floor.
 - 4) Interior face of door and applied drawer fronts.
- c. Semi-exposed Surfaces: Defined as those interior surfaces exposed to view when doors or drawers are opened:
- 1) Fixed, adjustable and pull-out shelves, including edgebanding of all sides.
 - 2) Dividers and partitions.
 - 3) Interior face of ends (sides), backs, and bottoms on cupboard and drawer units, including the interior surfaces of cabinet top members 36 inches or more above finished floor.
 - 4) Drawer sides, sub-fronts, backs, and bottoms.
 - 5) The underside of cabinet bottoms between 24 inches and 42 inches above finished floor.
 - 6) Security and dust panels or drawer stretchers.
- d. Concealed Surfaces: Defined as those exterior and interior surfaces that are covered or not normally exposed to view:
- 1) Toe space unless otherwise specified.
 - 2) Sleepers, stretchers, security panels, and solid sub-tops.
 - 3) Underside of bottoms of cabinets less than 24 inches above finished floor.
 - 4) Flat tops of cabinets over 80 inches above finished floor and not visible from an upper level.
 - 5) The three non-visible edges of adjustable shelves.
3. Hardwood Lumber:
- a. Type 1 Hardwood: Rift cut Red Oak Grade FAS, first and seconds or better, well matched for color and grain.
 - b. Type 2 Hardwood: Select grade hardwood of a species suitable for the specified purpose.
 - c. Provide all lumber clean and free of defects; kiln and air dried to a uniform minimum moisture content of 6 percent.
4. Hardwood Plywood:
- a. In accordance with ANSI/HPVA HP-1 latest edition unless otherwise specified herein.
 - b. Face Veneer:
 - 1) Grade:
 - a) Middle or higher of AA-1.
 - 2) Species:

- a) Exposed and Semi-Exposed Surfaces: Red Oak.
 - b) Concealed Surfaces: Plain sliced hardwood veneer, suitable for unexposed surfaces.
- 3) Cut:
- a) Rift, 1/50 inch thick minimum.
- 4) Matching Type:
- a) Slip.
- 5) Grain Direction:
- a) Vertical matched grain direction on cabinet drawer heads, doors, end panels, KO panels, KO aprons, table aprons, and filler panels.
 - b) Provide the following cabinet components with Horizontal grain direction unless otherwise noted; cabinet tops, bottoms, and fixed, adjustable and pullout shelves.
- 6) Color and Matching Selection:
- a) Compatible in color with solid stock and well matched in color and grain with adjacent plywood panels.
 - b) Hand select plywood prior to fabrication of cabinet faces for uniformity of color and grain on each run of bench. Darker and lighter panels are not acceptable in the same run of bench or same room after installation of casework.
- c. Cores:
- 1) Veneer: One piece hardwood solid core with crossbanding and hardwood face veneers. Minimum 9 ply for 1 inch, 7 ply for 3/4 inch, 5 ply for 1/2 inch, and 3 ply for 1/4 inch.
 - 2) Combination with composite crossbands: Minimum 7 ply for 3/4 inch. One piece hardwood solid core with two hardwood solid and two MDF crossbands and hardwood face veneers. MDF crossbands under face veneers.
- d. Bond Type: Type II
5. Hardboard:
- a. Tempered hardboard designed for strength and moisture resistance; consisting of wood fibers, highly compressed into a hard, dense, 1/4 inch thick, homogeneous sheet using natural resins and other added binders.
 - b. Physical Properties:
 - 1) Average modulus of rupture: 5300 psi.
 - 2) Density: 50 to 60 pounds per cubic foot.
 - 3) Tensile strength: 3,500 psi.
6. Adhesives: Type 2 or Type 3 water resistant glue with gluing done in clamps and jigs.
- a. Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
7. Dowels: Minimum 3/8 inch diameter hardwood, laterally fluted, chamfered ends.
- B. Sheet Steel: ASTM A1008 /1008M mild steel, cold-rolled, pickled, double annealed, and free from rust, scales, deep scratches, buckles, ragged edges, and other defects. Provide metallic furniture stock sheets.
- C. Stainless Steel:
- 1. Type: Unless otherwise noted on Drawings or elsewhere in this Section, provide Type 304; ASTM Specification Number A240/240M; stainless steel for tops, sinks, umbilical collar, shelves, and casework; gage as indicated on Drawings.

2. Finish: Exposed surfaces ground and polished to a Number 4 satin finish. Provide Type 304 with a tumbled finish approximating a Number 4 finish for nuts, screws, bolts, and rivets. Provide the grain finish direction as follows:
 - a. Vertical on door and drawer fronts
 - b. Vertical on tall storage cabinets door fronts and end panels.
 - c. Horizontal on all other exterior surfaces.
3. Welding: Provide all stainless steel welding material of type similar to sheet material. Provide welds made without discoloration; ground, polished, and passivated to blend harmoniously with a Number 4 satin finish.

D. Metal Gages for Sheet Steel and Stainless Steel:

1. Construct metal cabinets of sheet steel with minimum thickness in U.S. standard gage as follows:

Corner gussets for leveling bolts	11 gage (3.2 mm)
Apron corner braces, wall rail systems	12 gage (2.7mm)
Drawer support, hinge reinforcement, reinforcing gussets	14 gage (1.9 mm)
Horizontal rails and top rails, aprons, support struts, adjustable wall and island shelving, shelving hat channels	16 gage (1.5 mm)
Cabinet tops, end panels, bottoms, backs, toespace rails, security panels, vertical posts, vertical dividers, glazed doors, scribe strips, filler panels	18 gage (1.2 mm)
Door panels	18 gage (1.2 mm) exterior 20 gage (0.9 mm) interior
Enclosures, drawer fronts and bodies, pull-out tablet fronts and bodies, cabinet shelving, closure panels, overhead service carriers	20 gage (0.9 mm)

- E. Aluminum Type: Unless otherwise noted on Drawings or elsewhere in this Section, provide extruded aluminum per ASTM B 221 in either alloy 6063-T42 or 6063-T5.

F. Epoxy Resin Sheets:

1. Molded from modified epoxy resin that has been compounded and cured to provide optimum physical and chemical resistance required of a heavy duty laboratory working surface. Uniform mixture throughout, not dependent on a surface coating.
2. Physical Properties:
 - a. Compressive Strength (ASTM D695): 30,600 psi.
 - b. Flexural Strength (ASTM D790): 12,800 psi.
 - c. Tensile Strength (ASTM D638): 10,100 psi.
 - d. Heat Distortion (ASTM D648): 330 degrees F.
 - e. Water Absorption (ASTM D570): 0.018 percent.
 - f. Hardness, Rockwell M (ASTM D785): 108.
 - g. Fire Resistance (ASTM D635): Self Extinguishing.

G. Solid Phenolic Resin Sheets:

1. A self-supporting flat panel, specifically designed for laboratory work surfaces, based on thermosetting resins, homogeneously reinforced with cellulose fibers and manufactured under high pressure. Hardened chemical resistant polyurethane acrylic surface finish.
2. Physical Properties:
 - a. Material: Laboratory grade solid phenolic panel.
 - b. Density: 84 lbs/ft³ minimum.
 - c. Modulus of Elasticity: 1,305,340 psi minimum.
 - d. Shear Strength: 2000 psi minimum.
 - e. Compressive Strength: 24,000 psi minimum.
 - f. Flexural Strength: 11,603 psi minimum.

- g. Tensile Strength: 8,702 psi minimum.
- h. Weight: 93 pcf maximum.
- i. Fire Performance: Maximum flame spread of 25 per ASTM E84.
- j. Nonporous surface and edges.
- k. Microbial Characteristics: Will not support micro-organic growth.

H. Glass:

- 1. Laminated safety glass: Two outer plies of glass with a vinyl interlayer, nominal 1/4 inch thick.
- 2. Tempered safety glass: Heat treated glass, nominal 1/8 inch thick with a minimum of 88 percent clarity.

I. Polypropylene: Provide 1/4 inch thick sheets unless otherwise noted, white, flame retardant, stress relieved, smooth, free of surface blemishes with all edges rounded to 1/8 inch radius; low flame spread and low smoke generating type.

J. Sealant:

- 1. Epoxy sealant: Two-component epoxy compound.
- 2. Silicone sealant: One-part water base silicone sealing compound, in custom color matching color of surface to be sealed, Dow Corning 732 RTV or General Electric SCS 1200.

2.5 HARDWARE

A. Drawer and Hinged Door Pulls: 3/8 inch diameter stainless steel bow wire pull, 4-3/4 to 5 inches center to center with radiused corners and a projection of 1 inch to 1-1/2 inches. Model DP33B as manufactured by Mockett, or Model SS Bow 128 as manufactured by Schaub & Company.

- 1. Mount door pulls vertically and drawer pulls horizontally.
- 2. Provide drawers 28 inches wide and smaller with one pull per drawer face at centerline of cabinet.

B. Drawer and Pullout Shelving Slides:

- 1. Description: Full extension with soft closing action, ball bearing, rail mounted, multimembered slides fabricated of minimum 16 gage steel with an electro-zinc finish.
- 2. Acceptable Manufacturers:
 - a. Accuride International Incorporated, Santa Fe Springs, California
 - b. CompX Precision Slides, Waterloo, Ontario Canada
 - c. Knape and Vogt, Grand Rapids, Michigan
- 3. Drawer and Pullout Shelving Slide Ratings:
 - a. Drawer Width: 0 - 24 inches Maximum dynamic load rating 100 pounds
 - b. Drawer Width: Over 24 inches Maximum dynamic load rating 200 pounds
- 4. File Cabinet Drawer Slide Ratings:
 - a. Drawer Width: All sizes Maximum dynamic load rating 150 pounds
- 5. Slides shall have progressive movement with a positive stop at full extension or at a minimum 1 inch over travel and permit removal of drawer without use of tools. Drawers shall not lift out or otherwise be removable without the release of a locking device on each slide.
- 6. Dynamic Load Rating: Slides meet BIFMA "Business Institutional Furniture Manufacturers Association" Standards. 0.017 pounds per cubic inch at full travel plus or minus 1/4 inch for 50,000 cycles.

C. Pull-out Shelf Bumper: Provide on hinged side of pull-out shelf.

- 1. Basis of Design: Bainbridge Manufacturing, Inc., Part Number 1934.

D. Hinges:

1. Description: Institutional type, 5-knuckle, projecting barrel, minimum 2-1/2 inches long. Hinges for full overlay cabinets to have a wraparound design and slotted screw holes for adjustability.
 2. Material: Type 304 stainless steel, minimum 0.095 inches thick.
 3. Provide minimum of 2 hinges for doors under 48 inches high; minimum of 3 hinges for doors 48 inches to 84 inches high; and minimum of 4 hinges for doors over 84 inches in height.
 4. Mounting: Drill each leaf for screw attachment to door and frame. Use stainless steel flathead screws.
- E. Door Catches: Roller or magnetic type, adjustable, roller type operating with a built-in tension spring. Provide all parts of cadmium plated steel except roller. Attach to top of base cabinet doors, the bottom of wall cabinet doors, and at the top and bottom of tall cabinet right-hand doors. Provide a vertical sliding bolt assembly, astragal strip and dummy pull for the left-hand door of tall cabinets. Vertical sliding bolts; concealed in the stiles of glazed doors and between pans of solid doors to engage stainless steel keepers.
- F. Doorstop:
1. Provide at all tall cabinets with glass doors located adjacent to a benchtop or perpendicular surface, such as a wall.
 2. Provide with base and wall cabinets located adjacent to a perpendicular surface, such as a wall.
 3. Chain or cable, secured to the top of the door and cabinet frame. Provide in lengths required to stop the door from opening more than 90 degrees.
- G. Shelf clips: Die formed steel, zinc plated or polycarbonate clip with grooved plug and spring clip. Provide shelf clips adjustable on 1-1/4 inch centers and meet seismic requirements. For metal cabinets shelf adjustment holes are on nominal 1/2 inch centers.
- H. Locks:
1. Provide with base and wall cabinets as shown on the Drawings.
 2. Provide with all tall cabinets.
 3. Provide with all chemical storage cabinets.
 4. Unless otherwise directed, key locks differently within a room, differently between rooms. Provide Master key per Department with a Grandmaster for the building.
 5. Description: 5-pin tumbler, heavy duty cylinder cam lock type.
 6. Acceptable Manufacturers:
 - a. CompX National, Greenville, South Carolina.
 - b. Corbin, Berlin, Connecticut.
 - c. Best Lock Corporation, Indianapolis, Indiana.
 - d. Illinois Lock Company, Wheeling, Illinois.
 - e. Wesco International Inc., Pittsburgh, Pennsylvania.
 7. Finish: Exposed surfaces of locks shall match other casework hardware.
 8. Keying: Capacity for a minimum of 750 primary key changes. Master key 1 level with built-in flexibility to accommodate, if required, 3 levels; 1 Grandmaster, 59 Master groups and 70 Submaster groups with 13 primary changes under each.
 9. Keys: Stamped brass available from manufacturer or local locksmith, and supplied in the following quantities unless otherwise specified:
 - a. 2 for each keyed different lock.
 - b. 3 for each group keyed alike locks.
 - c. 2 for master keys for each system.
 - d. Provide controlled key blanks and registered key plan.
- I. File Suspension Rails: Provide each file drawer with a pair of 14 gage steel, file suspension rails.
- J. Leveling Glides: 2 inch diameter, two-piece pivot construction, steel housing, non-marring, phenolic or translucent plastic insert, 1/2 inch diameter, minimum 1-1/2 inch long zinc plated stems.

- K. Retractable Table Casters - Swivel Type with Retractable Leveling Glide: 4 inch overall height, with leveling glide that can be raised or lowered to handle the table load and prevent movement. Provide minimum load rating of 660 pounds per caster.
 - 1. Basis of Design: Zambus CarryMaster; Model AC-600S or Foot Master; Model GD-80-S-NYN-28.
- L. Drawer Identification Plate: Plate to be 3 inches wide by 2 inches high, Type 304 stainless steel, 16 gage with a number 4 finish. Attach plate to drawer with flathead stainless steel screws countersunk at each corner. Engrave each plate with 1/2 inch high numbering using Helvetica or Arial font. Engraved letters to be black. Numbering to be determined during Shop Drawing review.
- M. Grommets in Countertops: Manufacturer: MASTER CASTER Model 00203, or equal (no known equal). Grommet is 3 1/8 inch overall diameter, 1 1/8 inch height, black. Seal Grommets to bench with silicone sealer.

2.6 UNDER-COUNTER CORROSIVE AND/OR BASE STORAGE CABINETS (METAL) (B__N AND/OR B__S)

- A. Construction: Construct as specified for metal laboratory casework and as detailed on drawings.
- B. Casing: Bottom, top, back, door, and sides of cabinet shall be at least 18 gage sheet steel. Joints shall be welded airtight. Provide with adjustable zinc plated leveling legs.
- C. Door: Provide with keyed lock.
- D. Ventilation: Provide a 2-inch polypropylene vent pipe at the outside rear of the cabinet with 2 inlets, 1 high and 1 low. Extend vent pipe to 4 inches above the hood work surface, behind the baffle.
- E. Shelving: Provide each cabinet with a full width adjustable shelf.
- F. Liner: Provide cabinet with ChemCor thermoplastic coating as provided on the Justrite Centura line, molded or heat welded polypropylene liner, molded polyethylene liner, hi-tech polymer alloy or similar on all interior surfaces.
- G. Pan: Provide with 1/4 inch thick heat welded, polypropylene or ABS plastic pan, liquid tight, removable, 1 inch deep on bottom of cabinet and upper shelf.
- H. Hardware: All exposed to outside and inside of cabinet shall be Stainless Steel.
- I. Identification: Mark all undercounter ventilated cabinets with conspicuous red lettering on a contrasting background: CAUTION - ACIDS.
- J. Color: Dark Blue.
- K. Finish: Provide as specified for Metal Finishes in this section.

2.7 UNDER-COUNTER FLAMMABLE STORAGE CABINETS (METAL) (B__F)

- A. Construction: Construct as specified for metal laboratory casework and as detailed on drawings.
- B. Design: Construct cabinets in accordance with OSHA Regulations and the requirements of NFPA 30, National Fire Protection Association, Flammable and Combustible Liquids Code. Provide cabinets Factory Mutual (FM) approved or Underwriters Laboratories (UL) listed.
- C. Casing: Bottom, top, back, door, and sides of cabinet shall be at least 18 gage sheet steel, double walled with 1-1/2 inch air space. Joints shall be welded airtight. Provide with adjustable zinc plated leveling legs.

- D. Door: Provide with continuous piano hinge and a 3-point latching arrangement with door sill raised at least 2 inches above the bottom of the cabinet to retain spilled liquid within the cabinet. When more than 1 door is used, there shall be a rabbetted overlap of not less than 1 inch. Provide self-closing, self-latching door(s) with fusible link(s) to hold doors wide open and melt at 165 degrees Fahrenheit for automatic closure. Provide with keyed lock.
- E. Shelving: Provide each cabinet with a full width adjustable shelf.
- F. Grounding: Provide a grounding lug connection at back of cabinet.
- G. Identification: Mark all flammable storage cabinets with conspicuous red lettering on a contrasting background: FLAMMABLE - KEEP FIRE AWAY.
- H. Color: Yellow.
- I. Finish: Provide as specified for Metal Finishes in this Section, except interior shall be triple epoxy coated

2.8 TALL VENTILATED CABINETS (T36U)

- A. Description: All stainless steel construction. Include completely enclosed vertical posts. Include the items of cabinet construction listed.
 - 1. End Panels and Backs:
 - a. End panels and back formed from a single steel sheet with front edges formed to a channel shape and further offset to form a strike for doors and drawers.
 - b. Reinforce at front and rear corners with full upright posts containing shelf adjustment holes, maximum 1/2 inch (12 mm) on centers
 - 2. Bottoms:
 - a. Bottom and bottom rail formed from a single piece of metal with both sides and back formed up with a radius between flange and bottom for ease of cleaning. Form front rail to provide a strike for doors and a 4 inch (100 mm) high base.
 - b. Provide corner gussets at front and rear corners with 3/8 inch (10 mm) diameter leveling screws integral with bottom flange. Provide leveling bolt access hole with removable cover.
 - 3. Tops
 - a. One piece construction with front edge formed into a channel shape and offset for door recess and to provide a strike for doors. Turn down flanges at back and side edges for welding top to back and end panels.
 - b. Reinforce at front corners with gussets.
 - 4. Toespace Rails:
 - a. Install between end panels to provide a minimum toespace of 3 inches (75 mm) deep by 4 inches (100 mm) high.
 - b. Provide corner gussets at front and rear corners with 3/8 inch (10 mm) diameter leveling screws integral with bottom flange. Provide leveling bolt access hole with removable cover.
 - 5. Fixed and Adjustable Shelves:
 - a. Form front and back edges down 3/4 inch (19 mm) and returned back 3/4 inch (19 mm). Form ends down 3/4 inch (19 mm).
 - b. For shelves over 36 inches (915 mm) long or 16 inches (400 mm) deep, reinforce with a welded hat channel for the full length of the shelf.
 - c. Provide five full width shelves. Center shelf to be fixed by attaching to end panels with screws. Four shelves to be adjustable. Each shelf to be 1 inch (25 mm) away from back of cabinet for air circulation.
 - d. Adjustable on 1/2 inch (12 mm) centers.

- e. Front edge of shelf to be within 1 inch (25 mm) of inside face of door.
- 6. Hinged Solid Doors:
 - a. 3/4 inch (19 mm) double wall assembly.
 - b. Reinforce interior of front panel with welded steel hat channels. Prepaint and sound deaden interior. Weld outer corners and grind smooth.
 - c. Secure hinges with screws to internal full-height reinforcing in case and door. Hinges shall be removable; welding of hinges is not acceptable.
 - d. Doors shall close against rubber bumpers.
 - e. Each door to have a stainless steel louvered vent, 9 inch wide by 4 1/2 inch tall. Secure with stainless steel screws.

B. Ventilation: Provide 4 inch round duct collar at top of cabinet.

C. Finish: As specified for stainless steel laboratory casework.

2.9 TABLE - HEAVY DUTY, METAL LEG FRAME, INSTRUMENTATION - OFOI

- A. Load Rating: Capable of supporting a minimum of 800 pounds to accommodate robotic analyzers and heavy analytical instrumentation.
- B. Perimeter rails: 2 inches by 2 inches by 12 gage steel channel with a continuous inner reinforcement U-channel. Spot weld inner reinforcement channel approximately 12 inches on center, staggering weld on each side.
- C. Reinforcing cross rails: 2 inches by 2 inches steel C-channel. Attach to front and back perimeter rails at intervals not more than 33 inches on center.
- D. Legs: 2 inches by 2 inches steel tube with welded leg bracket. Attach legs with 2 bolts to front and back perimeter rails and welded to end perimeter rails. Provide each leg with a retractable caster.
- E. Stretcher rails: 2 inches by 2 inches steel tube. Connect by welding between two end legs and between two back legs.
- F. Casters: Provide swivel type with retractable integral leveling glide.
- G. Finish: Finish as specified for Metal Finishes under this section.
- H. Tops: As specified for Work Surfaces under this section. Refer to Table Schedule for type.

2.10 TABLE - WOOD LEG FRAME, FIXED HEIGHT (T06 - B1800 STUDENT TABLE)

- A. Perimeter rails: 2 inch by 4 inch solid Type 1 hardwood. Provide vertical grooves for corner stabilizer braces.
- B. Corner stabilizer braces: 12 gage zinc plated steel plate. Slide into perimeter rails groove. Attach to both rails with screws and bolted into leg at each corner. Groove rails for "Z" irons or drill for top attachment.
- C. Legs: 4 inches by 4 inches solid, Type 1 hardwood.
 - 1. Provide each leg with leveling glides.
- D. End and Middle Leg stretcher rails: 2 inch by 4 inch solid Type 1 hardwood. Connect by mortise and tenon and stove type bolt, washer and square nut.
- E. Top: As specified for Work Surfaces under this section. Refer to Table Schedule for material.

- F. Raceway: Provide Legrand pre-wired surface mounted electrical raceway with 20 amp cord and plug at each end of table. Cord is of sufficient length to reach the electrical floor box. Secure cord to inside of leg and underside of stretcher(s) for cord management.

2.11 SHELF FRAME ASSEMBLIES

- A. Nominal Shelf Dimensions:
1. Width: 24 inches, 30 inches, 36 inches, 42 inches or 48 inches
 2. Depth and weight capacity: 12 inches or 18 inches; 130 pounds per lineal foot, and 24 inches; 100 pounds 45 kg. per lineal foot.
 3. Thickness: 1 inch
- B. General Requirements:
1. Shelves shall have a 1 inch overhang behind the face of the rear tubular posts.
 2. Shelf Brackets: 11 gage metal with 3 blade hooks and rise above the shelf surface 6-inches to provide sides. Depth to match shelf depth. Provide one pair for each shelf. Screw shelves to each bracket. Top shelf assemblies shall have inverted shelf brackets.
 3. Front Retainer Rod: Type 304 stainless steel 1/4 inch diameter rod with a number 4 polished finish. Bend 90 degrees at 1-1/2 inches from each end. Insert bent ends into shelf to a depth of 1/2 inch with horizontal portion of rod at 1 inch above shelf.
- C. Wall Frame Assemblies:
1. Standards: 16 gage metal, single-slotted or double-slotted type on 1 inch centers, 30 inches long and 1 inch depth.
 2. Cross Rails and Cross Rail Brackets: 16 gage metal.
 3. Brackets: 11 gage metal with 3 blade hooks and rise above the shelf surface to provide sides. Screw shelves to each bracket.
- D. Adjustable Island and Peninsula Bench Shelving Assemblies:
1. Shelving Support: 2 inches by 6 inches by 12 gage steel, vertical and horizontal tubes with welded connections, single-slotted or double-slotted on 1 inch centers. Secure vertical tubes to floor and at underside of benchtop, as detailed on the Drawings. Factory finish as specified for metal finish in this section, with color selected by Architect.
 2. Brackets: 11 gage metal with 3 blade hooks and rise above the shelf surface to provide sides. Screw shelves to each bracket.
 3. Island Shelving Backsplash: 2 inch high, same material as shelf attached to rear edge of shelving with screws, maximum 12 inches on center.
- E. Shelf Materials:
1. Refer to Section 123553.19 for Wood.
- F. Finish as specified for wood finish in this section.

2.12 FINISHES

- A. Metal Finishes:
1. Finish casework, casework support structure, fume hood super-structure and other laboratory furnishings.
 2. Preparation: Spray clean metal with a heated cleaner / phosphate solution, pretreat with iron phosphate spray, water rinse, and neutral final seal. Immediately dry in heated ovens, gradually cooled, prior to application of finish.

3. Application: Electrostatically applied epoxy or urethane powder coat painting process that coats all hidden and exposed surfaces with an acid and abrasion resistant coating. Bake in a controlled high temperature oven to ensure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:
 - a. Exterior and interior surfaces exposed to view: 1.5 mil average and 1.2 mil minimum.
 - b. Backs of cabinets and other surfaces not exposed to view: 1.0 mil average.
 - c. Finish drawer bodies in matching or harmonizing color and apply corrosion resistant treatment to selected, concealed interior parts.
4. Color: Select from standard colors.
5. Metal Finish Performance Requirements:
 - a. Abrasion Resistance: Maximum weight loss of 5.5 mg per 100 cycle when tested on a Taber Abrasion Tester Number E40101 with 1000 gm wheel pressure and Calibrase Number CS10 wheel.
 - b. Hardness: Surface hardness equivalent to 4H or 5H pencil.
 - c. Humidity Resistance: Withstand 1,000 hour exposure in saturated humidity at 100 degrees F.
 - d. Moisture Resistance: No visible effect to surface finish after boiling water trickled over test panel inclined at 45 degrees Fahrenheit for 5 minutes. No visible effect to surface finish following 100 hour continuous application of a water soaked cellulose sponge, maintained in a wet condition throughout the test period.
 - e. Adhesion: Score finish surface of test panel with razor blade into 100 squares, 1/16 inch by 1/16 inch, cutting completely through the finish but with minimum penetration of the substrate, and brush away particles with soft brush. Minimum 95 squares shall maintain their finish.
 - f. Salt Spray: Withstand minimum 200 hour salt spray test, conforming to ASTM B117-59 procedure.

B. Wood Finish

1. Finish casework, casework support structure and other laboratory furnishings.
2. Preparation: Sand exposed surfaces smooth, free from dirt, defects, and mill marks resulting from machining.
3. Stain: Apply stain to all exposed exterior and interior casework surfaces. Allow surfaces to completely dry under controlled conditions before applying subsequent coats. Force dry in dust-free atmosphere, sand and wipe surfaces clean between coats. Apply and wipe dry in a manner to achieve a match with the selected color sample, upon completion of application of the finish coats. Color selection by Architect.
4. Finish surface: Smooth, satin luster finish. Provide water clear and bright finish on exterior and interior surfaces exposed to view. Cloudy, muddy finishes or finishes carrying tinting pigment will not be acceptable.
5. Finish coats: After staining, apply 1 coat of clear sealer and 2 coats of highly chemical resistant, catalyzed polyurethane or acrylic urethane with "blocker" additive to resist fading of finish of sunlight to all exposed and unexposed surfaces.

2.13 WORK SURFACES

A. Epoxy Resin:

1. Available Manufacturers:
 - a. American Epoxy Scientific, LLC.
 - b. Durcon, a Wilsonart Company
 - c. Kewaunee Scientific Corporation
2. Thickness: 1 inch thick unless otherwise noted on Drawings. Check thickness before fabrication. Each corner of top shall not deviate more than plus or minus 1/32 inch from nominal.
3. Warpage: Check top for warpage before fabrication. Place slab on a true plane formed by a surface plate of Tool Room Grade B or better. Measure in unrestrained condition. Top will be accepted for use if there is no gap exceeding 1/16 inch in a 36 inch span or 3/32 inch in a 96 inch span.
4. Fabrication:

- a. Provide in longest practical lengths. Bond all joints with a highly chemical and corrosion resistant cement having similar properties as the base material. Provide a 1/8 inch wide drip groove on underside of all exposed edges set back 1/2 inch from edge of top. Finish exposed edges.
 - b. Size Tolerances: Length, plus or minus 1/8 inch. Width, plus or minus 1/16 inch.
 - c. Size Tolerances: Length, plus or minus 1/8 inch. Width, plus or minus 1/16 inch.
 - d. Squareness: Plus or minus 1/64 inch for each 12 inches. A top spanning 48 inches; held to plus or minus 1/16 inch.
 - e. Location Of Cutouts And Drillings: Plus or minus 1/8 inch.
 - f. Sizes Of Cutouts And Drillings: Plus 1/8 inch, minus 0.
5. Curbs: Supply loose for field application. Provide curbs 4 inches high by 3/4 inches thick unless otherwise indicated on Drawings. Where tops abut wall, casework, or fume hood, supply an end curb. Caulk joints between curb and walls, fume hoods, and cabinets with acid-resistant silicone caulk.
6. Color: Manufacturer's standard light grey color.
- B. Stainless Steel:
1. Thickness: 16 gage, Type 304, stainless steel with a Number 4 polish finish over a hardwood perimeter frame with a total thickness of 1 inch, unless otherwise noted on Drawings.
 2. Fabrication:
 - a. Finish at the factory and include all cutouts. Provide top with 1/2 inch return flange under frame and 16 gage steel reinforcing channels applied to underside of top where necessary to ensure rigidity. Coat underside of top with sound dampening material.
 - b. Form edges, flanges and curbs integrally with top from 1 sheet of metal. Provide with marine edges unless otherwise noted on Drawings. Provide curbs 4 inches high.
 - c. Joints: Electrically weld all shop and field joints; grind smooth and polish.
 - d. Size Tolerances: Length, plus or minus 1/8 inch. Width, plus or minus 1/16 inch.
 - e. Squareness: Plus or minus 1/64 inch for each 12 inches. A top spanning 48 inches; held to plus or minus 1/16 inch.
 - f. Location of Cutouts And Drillings: Plus or minus 1/8 inch.
 - g. Sizes of Cutouts And Drillings: Plus 1/8 inch, minus 0.
 - h. Caulk joints between curb and walls, fume hoods, and cabinets with acid-resistant silicone caulk.
- C. Solid Phenolic Resin:
1. Available Manufacturers:
 - a. FunderMax North America, Inc.
 - b. Trespa North America, Ltd.
 2. Materials: As specified in Materials of this specification section
 3. Thickness: 1 inch thick unless otherwise noted on Drawings. Check thickness before fabrication. Each corner of top shall not deviate more than plus or minus 1/32 inch from nominal.
 4. Provide in longest practical lengths to provide minimum number of joints.
 5. Installation Materials: Provide solid phenolic laboratory top manufacturer's joint adhesive and sealants as required to suit project conditions.
 6. Fabrication:
 - a. Fabricate solid phenolic laboratory tops in accordance with manufacturer's recommendations, approved submittals and SEFA 3.
 - 1) Comply with requirements of Architectural Woodwork Standards Premium grade.
 - b. Edge Treatment:
 - 1) Ease all top edges and vertical corners to 1/4 inch radius and sand smooth.
 - 2) Provide drip groove unless otherwise indicated.

7. Curbs: Supply loose for field application in same thickness as countertops. Provide curbs 4 inches high unless otherwise indicated on Drawings. Where tops abut wall, cabinets or fume hood, supply an end curb. Caulk joints between curb and walls, fume hoods, and cabinets with acid-resistant silicone caulk.
8. Color: Fundermax DEEP BLACK in Darkroom +Film and CHARCOAL in Main photo Lab + Workroom unless otherwise noted..
9. Finish: Matt sheen.

2.14 SINKS

A. Epoxy Resin Sink:

1. Available Manufacturers:
 - a. American Epoxy Scientific, LLC.
 - b. Durcon, a Wilsonart Company.
 - c. Or equal, (no known equal).
2. Description: Integrally molded from modified thermosetting black epoxy resin, and oven cured. Minimum wall thickness of 1/2 inch with all interior corners coved to 1-1/2 inch radius and bottoms pitched to end outlet opening.
3. Sink mounting methods:
 - a. Drop-in: Supported by an upper flange from the work surface. Top edge of sink positioned 1/8 inch below the work surface with a 30 degree bevel from the top of the work surface to the top of the sink lip. Joint between sink and work surface shall not exceed 1/8 inch plus or minus 1/16 inch. Seal joint between sink and top with epoxy sealant.
 - b. Under Mount: Support sink at bottom using an upper direction compression support system. Seal joint between top and sink with silicone sealant.
4. Provide sink with the following accessories:
 - a. Outlet: 1-1/2 inch NPS.
 - b. Overflow: Open end overflow standpipe. Overflow to be 2 inches shorter than depth of sink.
 - c. Strainer: Removable disc strainer.
 - d. Tailpiece: Town & Country Plastics Model PP-18, R&G Sloane Part Number 7218; or Scientific Plastics Company, Inc., Part Number W81595-158.
5. Color: Sink color to match top color.

B. Stainless Steel Sink:

1. Available Manufacturers:
 - a. Just Manufacturing Company.
 - b. Elkay Manufacturing.
2. Description: Minimum 18 gage, Type 304 stainless steel, Number 4 polish. Provide radius cove at vertical and horizontal corners and pitch bottom to drain. All sink joints; butt welded, ground smooth, and polished to render all joints seamless. Soldering will not be permitted in conjunction with sink construction. Provide all sink units designed and fabricated with sufficient reinforcement to prevent oil canning. Apply heavy mastic type sound deadening coating to underside of sinks. Faucet holes to be reinforced with 16 gage stainless steel hat channel on the underside.
3. For sinks greater than 10 inches deep or with a perimeter greater than 96 inches provide minimum 16 gage, Type 304 stainless steel, Number 4 polish.
4. Except for sinks integral with stainless steel top, mount sinks with an integral frame.
5. Provide sink with the following accessories:
 - a. Stainless steel drain outlet.
 - b. Stainless steel open end overflow standpipe. Standpipe to be 2 inches shorter than depth of sink.
 - c. Strainer.
 - d. Tailpiece: Just Model # J-15-SSW-316; or Elkay Model # LK 338.

C. Stainless Steel Scullery Sink:

1. Fabricate from 14 gage, Type 304 stainless steel with a Number 4 finish. Provide 1 inch radius cove at vertical and horizontal corners and pitch bottom to drain. All sink joints; butt welded, ground smooth and polished to render all joints seamless. Soldering will not be permitted in conjunction with sink unit construction. Provide all sink units designed and fabricated with sufficient reinforcement to prevent oil canning. Apply heavy mastic type sound deadening coating to underside of sinks, tops, backsplashes, and sidesplashes. Fixture holes to be reinforced with a continuous 14 gage hat channel on the backside of the backsplash. Length as required for fixture quantity. Provide 1 inch wide by 4 inch high sidesplash where sink abuts a vertical surface. Caulk joint between sink unit and any vertical surface with an acid-resistant silicone caulk.
2. Sink: Provide with stainless steel open end overflow stand pipe, strainer, and tailpiece. Standpipe to be 2 inches shorter than depth of sink.
3. Frame and leg members: 2 inches square, 14 gage. Provide horizontal front shelf support frame members to be removable as detailed on the Drawings. All other connections welded with a Number 4 finish. Provide leg members with leveling glides.
4. Removable shelves: 14 gage, Type 304 stainless steel with a Number 4 finish. Provide bends on the front and the back of the shelf as detailed on the Drawings to provide shelf support and an integral backsplash.

2.15 LABORATORY SERVICE FIXTURES

A. General:

1. Installation: Provide and install at point of use all service fixtures. Connect to the service piping systems specified in Division 22. Provide the product of one manufacturer for all laboratory service fixtures, including fixtures supplied with fume hoods and emergency shower and eye wash units. Provide all fixtures designed for laboratory use and comply with SEFA 7.
2. Refer to Laboratory Service Fixture Schedule for fixture types and descriptions.
3. Acceptable Manufacturers:
 - a. WaterSaver Faucet Company. WaterSaver fixture numbers are referenced herein.
 - b. Broen-LAB A/S
 - c. Chicago Faucet Company.
4. Materials: Provide the bodies of service valves, fixtures and accessories of cast or forged brass with a minimum copper content of 85 percent. Fabricate assembly components and operating parts such as valve stems, renewable units, packing nuts, outlet nozzles, and straight serrated hose ends from solid brass bar stock. Fabricate replaceable seats, needle cones, valve disc screws, and other accessories from monel metal or stainless steel alloys especially selected for use intended.
5. Assembled at the factory: Service fixtures, including the mounting of valves and shanks to turrets, flanges, and other mounting accessories.
6. Furnish and install nipples, locknuts, washers, shanks and other accessories required to properly mount and connect the fixtures.
7. Testing: Individually factory test fixtures. Valves and fixtures, except water fixtures, shall withstand a test pressure of 100 pounds per square inch. Test water fixtures at 80 pounds per square inch.
8. Fixtures located on the same plane shall have their handles project the same distance from the plane of reference to present a uniform, related appearance, regardless of valve type.
9. Identify mechanical services with full view colored index buttons in accordance with SEFA 7 Color Code.

B. Water Valves:

1. Renewable unit containing all working parts which are subject to wear, including stainless steel or monel metal seat, monel metal screw, heavy duty seat disk, Teflon packing, and an integral or external adjustable volume control.
2. Provide unit capable of being readily converted from compression to self closing, and vice versa, without disturbing faucet body proper and shall also be capable of being readily converted from water construction to needle valve or steam valve construction without disturbing faucet body.
3. Provide unit sealed in valve body with special composition gasket. Metal-to-metal or ground-joint type of sealing not acceptable.

- C. Fine Control Valves:
1. Fine Control valves for special gas service: As described for needle valves with the following additions.
 - a. Fine stem threads with approximately 30 threads per inch.
 - b. Renewable stainless steel needle and seat with 1/8 inch orifice.
 - c. Constructed to maintain a constant flow rate of 4 bubbles per 15 seconds as valve is tested out under 50 pounds, 100 pounds, 150 pounds, 200 pounds, and 250 pounds of nitrogen pressure.
- D. High Purity Water Valves:
1. Forged brass body with all interior components coming in contact with water constructed of polypropylene.
 2. Maximum working pressure of 50 psig.
 3. Provide with 3/8 inch brass riser and gooseneck with polypropylene lining.
 4. Provide with polypropylene serrated tip at the outlet.
- E. Laboratory Ball Valves: Straight pattern body, valve stem with integral chrome plated ball and TFE-coated O-rings stem seals in valve body, molded TFE valve seals, and tested at 125 psi nitrogen under water. Valves shall have chrome plated forged brass lever-type handle with screw-on type index requiring less than 5 pounds pressure to actuate. Provide with removable 10 serrated hose end.
- F. Foot-Operated Water Valves:
1. Forged brass body and pedals mounted on hinged bracket.
 2. Self-closing renewable unit containing all working parts which are subject to wear, including stainless steel or monel metal seat, monel metal screw, heavy duty seat disk, Teflon packing, and an integral or external adjustable volume control.
- G. Goosenecks: Hot water/cold water gooseneck mixers shall swivel. Provide swivel point at turret or at valve level if wall or panel mounted. Provide swing joints with heavy Teflon packings. All goosenecks shall provide full thread for attachment of antisplash outlet fixtures, serrated tips or filter pumps.
- H. Pre-Rinse Units: Provide self-closing squeeze valve with rubber-bound spray head, insulated handle and locking ring. Valve mounted on spring loaded 39-inch stainless steel hose.
- I. Aerators: Aerators shall have 3/8 inch NPS male inlet. Provide with integral flow control that adjusts between 0.5 GPM and 3.0GPM. Flow control to be set as indicated on Drawings.
- J. Serrated Tips: Serrated tip fixtures shall have 3/8 inch IPS thread with hose end being tapered and shall not have less than 10 serrations. Provide 1/8 inch diameter of orifice in serrated tip, except where otherwise specified. For water units provide with integral flow control that adjusts between 0.5 GPM and 3.0 GPM. Flow control to be set as indicated on Drawings.
- K. Turrets: Round type design, brass drop forging, as indicated on Drawings. One-way or two-way as required with 3/8 inch IPS female inlet thread for connections. Furnish units with brass shanks, brass locknuts, and washers.
- L. Electrical Fixtures – Pedestal Type: Cast aluminum box complete with cover plates. Fabricate units with sloped single face or double face, as indicated, and conceal mounting holes in base for attaching to casework. UL listed. Provide holes tapped for conduits and grounding screws. Coordinate required face plates with receptacles and other devices specified in Division 26.
- M. Industrial Water Sign: 1/8 inch thick black laminated plastic with engraved white letters "INDUSTRIAL WATER DO NOT DRINK". Provide a sign at all industrial hot and industrial cold water valves. At panel mounted valves mount sign on panel above valve handle and at all gooseneck fixtures provide with 3/8 inch thick split ring mounting bracket.

- N. Fixture Finish: Fixtures shall be coated with an electrostatically applied epoxy powder coating in the color of Starburst Metallic.
- O. Faucet and Valve Handles: Molded plastic or wrist blade type with a screw-on type index disc. Provide color coded handle to match the fixture's service. Provide color code requirements for service fixtures as follows:

Service	Index Color	Symbol	Handle Color
Compressed Air	Grey	CA	Orange
Potable Cold Water	Grey	CW	Green
Potable Hot Water	Grey	HW	Red
Gas	Grey	GAS	Blue
Industrial Cold Water	Grey	ICW	Green
Industrial Hot Water	Grey	IHW	Red
Lab Air	Grey	LA	Orange
Deionized Water	Grey	DI	White
Vacuum	Grey	VAC	Yellow

- P. Wrist blade Handles: Install handles so blades are perpendicular to the benchtop in the off position and horizontal to the benchtop in the open position.

2.16 EMERGENCY SHOWER AND EYE WASH UNITS

- A. General: Provide and install at point of use all emergency shower and eyewash units. Connection to the service piping systems specified in Division 22. Provide units that meet the requirements of ANSI Standard Z358.1.
- B. Acceptable Manufacturers:
 1. Water Saver Faucet Company. WaterSaver fixtures are referenced herein.
 2. Broen-LAB A/S.
 3. Guardian Equipment.
- C. Emergency Showers:
 1. Deluge type with a concealed stay-open ball valve. Provide with "Panic Bar" activation as detailed on the Drawings.
 2. Shower head, nipple, and escutcheon: stainless steel. Maximum mounting height of shower head 96 inches.
 3. Design valve so that water flow remains on without requiring use of the operator's hands.
 4. All exposed valves, piping, and associated devices: Stainless steel.
- D. Recessed Swing-Down Eye/Face Wash:
 1. Barrier free, wall mounted, "AutoFlow", swing-down eye/face wash with recessed stainless steel cabinet.
 2. Furnish and install units to meet the requirements of the Americans With Disabilities Act (ADA).
 3. Cabinet: Type 304 stainless steel with Number 3 satin finish.
 4. All exposed valve components: Polished chrome plated brass.
 5. Valve: Plug-type design with Teflon coated "O" rings to seal valve orifice. Water flow activated by swinging outlet heads from the vertical to the horizontal position. Water to turn on when the arm assembly is no more than 30 degrees from horizontal. Cabinet shall house valve assembly.
 6. Furnish with 2 polypropylene fine spray heads with polyurethane filter and integral volume control.
 7. Cabinet shall house the emergency shower stay-open ball valve with "Panic Bar" operation.
 8. Cabinets located in rated walls shall be fire rated to maintain the integrity of the rated wall.
- E. Test Kit for Emergency Shower and Safety Stations:

1. Provide 48 inch telescopic aluminum pole, 11-1/2 inch diameter Tyvek test chute, 5 gallon plastic pail and eyewash tester.

F. Deck Mounted and Panel Mounted Swing-Down Eyewash:

1. Deck mounted and panel mounted, "AutoFlow", swing-down eyewash unit.
2. Valve: Plug-type design with Teflon coated "O" rings to seal valve orifice. Water flow activated by swinging outlet heads from the vertical to the horizontal position. Water to turn on when the arm assembly is no more than 30 degrees from horizontal.
3. Furnish with 2 polypropylene fine spray heads with polyurethane filter, integral volume control and integrated nylon flip-top dust covers.
4. Finish: Match laboratory services fitting finish.

2.17 GAS CYLINDER RESTRAINTS

- A. Description: Provide metal framing system members, fastened to the wall or laboratory bench, for mounting of cylinder restraint devices.
- B. Metal Framing System Components: Consist of two 12 gage steel channel members with two male swivel hanger fittings, Number M2350, on each member for each cylinder. Unistrut Part Numbers are referenced. Finish as specified for metal finish in this section, with color selected by Architect.
 1. Acceptable Manufacturers:
 - a. Unistrut Corporation
 - b. Elcen
 - c. Grinnell Power Strut
- C. Chain Restraints: Consist of 3/16 inch diameter Type 316 stainless steel chain Number 3618T715, length as required to restrain a standard 9 or 10 inch gas cylinder, with a Type 316 stainless steel threaded connector Number 3711T33, on one end of the chain, and a Type 316 stainless steel load rated spring snap with a minimum load rating of 300 pounds, Number 8907T11, on the other end of the chain.
 1. Acceptable Manufacturer /Distributor:
 - a. McMaster-Carr

2.18 GAS CYLINDER RACKS

- A. Description: Provide metal framing system members, fastened to the wall and floor, for mounting of cylinder restraint devices.
- B. Metal Framing System Components: Consist of two 12 gage steel channel members and 1/4 inch thick angle fittings with two male swivel hanger fittings, on upper and lower members for each cylinder. Unistrut Part Numbers are referenced. Finish as specified for metal finish in this section, with color selected by Architect.
 1. Acceptable Manufacturers:
 - a. Unistrut Corporation
 - b. Elcen
 - c. Grinnell Power Strut
- C. Chain Restraints: Consist of 3/16 inch diameter Type 316 stainless steel chain Number 3618T715, length as required to restrain a standard 9 or 10 inch gas cylinder, with a Type 316 stainless steel threaded connector Number 3711T33, on one end of the chain, and a Type 316 stainless steel load rated spring snap with a minimum load rating of 300 pounds, Number 8907T11, on the other end of the chain.
 1. Acceptable Manufacturer /Distributor:
 - a. McMaster-Carr

2.19 SOURCE QUALITY CONTROL TESTING OF METAL FINISH

- A. Metal Finish: Meet or exceed the latest edition of the following Section and Articles of SEFA-8-M Recommended Practices;
 - 1. 8.0 Cabinet Surface Finish Tests"
 - a. 8.1 Chemical Spot Test.
 - b. 8.2 Hot Water Test.
 - c. 8.3 Impact Test.
 - d. 8.4 Paint Adhesion Test.
 - e. 8.5 Paint Hardness Test.
- B. Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor.
- C. Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the above SEFA-8-M Recommended Practices.

2.20 SOURCE QUALITY CONTROL TESTING OF WOOD FINISH

- A. Wood Finish: Meet or exceed the latest edition of the following Section and Articles of SEFA-8-W Recommended Practices:
 - 1. 8.0 Cabinet Surface Finish Test:
 - a. 8.1 Chemical Spot Test.
 - b. 8.2 Hot Water Test.
- B. Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor.
- C. Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the above SEFA-8-W Recommended Practices.

2.21 SOURCE QUALITY CONTROL TESTING OF EPOXY WORK SURFACES

- A. Meet or exceed the latest edition of the following Section and Articles of SEFA-3 Recommended Practices:
 - 1. 2.1 Chemical/Stain Resistance Test:
 - a. Test Method A.
 - b. Test Method B.
- B. Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor.
- C. Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the above SEFA-3 Recommended Practices

2.22 SOURCE QUALITY CONTROL TESTING OF SOLID PHENOLIC RESIN WORK SURFACES

- A. Meet or exceed the latest edition of the following Section and Articles of SEFA-3 Recommended Practices:
 - 1. 2.1 Chemical/Stain Resistance Test:
 - a. Test Method A.
 - b. Test Method B.

- B. Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor.
- C. Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the above SEFA-3 Recommended Practices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.2 DELIVERY

- A. Delivery casework systems in two stages:
 - 1. Deliver fixed casework and fume hoods.
 - 2. Deliver flexible casework systems.
- B. Deliver flexible casework systems just prior to building occupancy, as instructed by Architect.

3.3 PREPERATION

- A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

3.4 INSTALLATION

- A. General:
 - 1. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified.
 - a. Respective manufacturer/fabricator's written installation instructions.
 - b. Approved submittals.
 - c. Contract Documents.
 - 2. Control of Corrosion: Prevent galvanic action and other forms of corrosion by isolating metals and other materials from direct contact with incompatible materials.
 - 3. Install casework, tables, casework support systems, overhead service drops, fume hoods and local point exhaust devices in accordance with manufacturer's instructions and approved Shop Drawings, and under the supervision of the manufacturer's trained personnel.
 - a. Include installation of service fixtures. Final connections to services are specified in Division 22.
 - 4. Anchor casework and fume hoods securely in place with appropriate seismic tie-down kits, in accordance with calculations and requirements.
- B. Casework Installation:
 - 1. Install, plumb, level, true and straight with no distortions. Shim as required, using concealed shims. Securely anchor to building structure. Where laboratory furniture abuts other finished work, scribe and apply filler strips for accurate fit with fasteners concealed where practicable.

2. Installation of each individual bench run shall start at the high point of the floor under that bench run with levelers screwed in as much as possible.
 3. Where required, assemble units into one integral unit with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.
 4. At fixed casework installations provide galvanized backer plates at toe kicks to receive applied base where floor elevation deviations cause gaps over one inch between bottom of cabinet base and floor.
 5. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by Manufacturer.
 6. Securely fasten tall cabinets, fume hood superstructures and tall flammable storage cabinets to solid support material near top of cabinet.
 7. Reinforcement of stud walls to support cabinets, shelving, and other wall mounted laboratory furnishing items: Done during wall erection by trade involved. Laboratory furniture company/supplier is responsibility for indicating on Shop Drawings the accurate location and sizing of reinforcement.
- C. Wall Cabinet Installation:
1. Securely fasten to solid supporting material, not plaster, lath, or wallboard. Anchor, adjust, and align wall cabinets as specified for base cabinets.
 2. Reinforcement of stud walls to support wall mounted cabinets: Done during wall erection by trade involved. Laboratory furniture company/supplier is responsibility for indicating on Shop Drawings the accurate location and sizing of reinforcement.
- D. Work Surface Installation:
1. Field jointing where practicable: Made in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by Manufacturer. Locate field joints as shown on accepted Shop Drawings, factory prepared so that there is no job site processing of top and edge surfaces.
 2. Abut top and edge surfaces in 1 true plane, with internal supports placed to prevent any deflection.
 3. Provide all holes and cutouts as required for built-in equipment and mechanical and electrical service fixtures. Prior to making openings, verify size of opening with actual size of equipment to be used. Form inside corners to a radius of not less than 1/8 inch. After sawing, rout and file cutouts to ensure smooth, crack free edges. Seal exposed edges after cutting with a waterproofing material recommended by manufacturer.
 4. Secure tops to support with concealed Z-Type, angle type fastening, "Liquid Nails", Ply400/Ply 200 adhesive or equivalent. Fastening devices spaced no more than 3 feet on center. Adhesives shall be liberally applied for solid anchoring of tops.
 5. Plastic laminate worktop joints: 1/4 inch diameter bolt type "dog-bone" or "tite-joint" fasteners routed into bottom surface of worktops. Provide flush hairline joints in top units and seal with silicone sealant.
 6. Epoxy Resin Work Surface Joints: 3/32 inch flush and smooth with epoxy sealant.
 7. Stainless Steel Work Surface joints: Electrically weld all shop and field joints; grind smooth and polish.
 8. Caulk joints between curb and walls, fume hoods, and cabinets with acid-resistant silicone caulk.
- E. Sink Installation: Set in chemical resistant sealing compound sinks which were not factory installed and secured and supported per manufacturer's recommendations.
- F. Accessory Installation: Install accessories, fixtures and equipment in accordance with manufacturer's recommendations ready for final connection to services.
- G. Refer to Specification Section 115313 for additional information regarding fume hood installation.

3.5 FIELD QUALITY CONTROL

- A. **Manufacturer/Fabricator's Field Service:** Manufacturer/fabricator's qualified technical representative shall inspect first day's Work and periodically inspect Work to ensure installation is proceeding in accordance with manufacturer/fabricator's designs, recommendations, instructions, and warranty requirements. Representative shall submit written reports of each visit indicating observations, findings, and conclusions of inspection.
- B. **Owner's Testing Agency Field Service:** The Owner may employ and pay a qualified independent testing agency to perform field quality control. Materials and installation failing to meet specified requirements shall be replaced at Contractor's expense. Retesting of materials and installations failing to meet specified requirements shall be done at Contractor's expense.

3.6 ADJUSTING

- A. Repair or remove and replace defective work, as directed by Architect upon completion of installation.
- B. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly.

3.7 CLEANING AND PROTECTION

- A. Clean shop finished casework and fume hoods, touch up as required, and remove and refinish damaged or soiled areas.
- B. Cover casework for protection against soiling and deterioration during remainder of construction period.
- C. Clean countertops with diluted dishwashing liquid and water leaving tops free of all grease and streaks. Use no wax or oils.
- D. If steel wool is used in cleaning stainless steel, use only stainless wool.
- E. Protect casework and fume hoods before, during, and after installation. Materials damaged due to improper protection are cause for rejection.

END OF SECTION

SECTION 123553.13 – STAINLESS STEEL LABORATORY CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes metal laboratory casework.
- B. Related Requirements:
 - 1. Refer to Section 123553 "General Requirements for Laboratory / Arts Casework and Fume Hoods" for all References, Approved manufacturers, Materials, Hardware, Finishes, Installation, etc.
 - 2. Section 123553.03 "Adaptable Laboratory Casework Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Refer to Section 123553 for approved manufacturers.

2.2 CASEWORK DESIGN

- A. Comply with SEFA 8-M "Laboratory Grade Metal Casework."
- B. Full overlay style: Square edged door and drawer fronts overlapping the openings on all four sides. In elevation, hold the reveal between end panel and door or drawer edge to a maximum of 1/8 inch wide. Hold spaces between abutting doors and drawers to a maximum of 1/8 inch wide, both horizontally and vertically, and shall be accurate and uniform, forming a continuous reveal throughout full length of assembled casework. Hold the reveal between top of cabinet and door or drawer edge to a maximum of 1/4 inch wide.
- C. Self-Supporting Units: Completely welded shell assembly without applied panels at ends, backs or bottoms, so that cases can be used interchangeably or as a single, stand-alone unit.
- D. Interior of Case Units: Easily cleanable, flush interior. Base cabinets, 30 inches and wider, with double swinging doors shall provide full access to complete interior without center vertical post.
- E. Drawers: Sized on a modular basis for interchange to meet varying storage needs, and designed to be easily removable in field without the use of special tools.
- F. Case Openings: Rabbeted-like joints all 4 sides of case opening for hinged doors and 2 sides for sliding doors in order to provide dust resistant case.
- G. Secure intersection of case members with spot and arc welds.
- H. Testing of Casework, Tables, and Shelving: Meet or exceed SEFA 8-M.

2.3 CASEWORK FABRICATION

- A. General: Include completely enclosed vertical posts. Include the items of cabinet construction listed. Exclude provisions for doors in open shelf cabinets or cubbies.
- B. Floor Mounted Base Cabinets:
 - 1. End Panels and Backs:

- a. End panels and back formed from a single steel sheet with front edges formed to a channel shape and further offset to form a strike for doors and drawers.
 - b. Reinforce at front and rear corners with vertical posts containing shelf adjustment holes, maximum 1/2 inch on centers.
 - c. Provide removable backs on all base cabinets, except units with security panels and sink cabinets, to allow access to service piping from the front of the unit
 - d. All sink cabinets to have partial height back panels to allow passage of drain line and piping to service chase.
2. Bottoms:
- a. Bottom and bottom rail formed from a single piece of metal with both sides and back formed up with a radius between flange and bottom for ease of cleaning. Form front rail to provide a strike for doors and drawers.
 - b. Reinforce at front corners with gussets.
3. Front Top Rails:
- a. Provide flush at face of cabinet and interlock within the flange at the top of the end panels. Form front of rail to provide a strike for doors and drawers.
 - b. Reinforce at front corners with gussets.
4. Toespace Rails:
- a. Install between end panels to provide a minimum toespace of 3 inches deep by 4 inches high.
 - b. Provide corner gussets at front and rear corners with 3/8 inch diameter leveling screws integral with bottom flange. Provide leveling bolt access hole with removable cover.
5. Intermediate Rails:
- a. Provide between drawers and doors, and between multiple drawers at all security panels.
 - b. Recessed behind doors and drawer fronts.
 - c. Removable for later revision in cabinet configuration.
6. Drawers:
- a. Drawer front: 3/4 inch double wall assembly, prepaint prior to assembly and sound deaden, weld top front corners and grind smooth.
 - b. Drawer body: One-piece construction including bottom, 2 sides, back, and inner front. Fully covered at interior bottom.
 - c. Drawers shall close against rubber bumpers.
 - d. Provide security panels for drawers with keyed different locks.
- C. Tall Cabinets:
1. End Panels and Backs:
 - a. End panels and back formed from a single steel sheet with front edges formed to a channel shape and further offset to form a strike for doors and drawers.
 - b. Reinforce at front and rear corners with full upright posts containing shelf adjustment holes, maximum 1/2 inch on centers.
 2. Bottoms:
 - a. Bottom and bottom rail formed from a single piece of metal with both sides and back formed up with a radius between flange and bottom for ease of cleaning. Form front rail to provide a strike for doors and a 4 inch high base.
 - b. Provide corner gussets at front and rear corners with 3/8 inch diameter leveling screws integral with bottom flange. Provide leveling bolt access hole with removable cover.
 3. Tops
 - a. One piece construction with front edge formed into a channel shape and offset for door recess and to provide a strike for doors. Turn down flanges at back and side edges for welding top to back and end panels.

- b. Reinforce at front corners with gussets.
- 4. Fixed and Adjustable Shelves:
 - a. Form front and back edges down 3/4 inch and returned back 3/4 inch. Form ends down 3/4 inch.
 - b. For shelves over 36 inches long or 16 inches deep, reinforce with a welded hat channel for the full length of the shelf.
 - c. Provide five full width shelves. Center shelf to be fixed by attaching to end panels with screws. Four shelves to be adjustable.
 - d. Adjustable on 1/2 inch centers.
 - e. Front edge of shelf to be within 1 inch of inside face of door.
- 5. Hinged Solid Doors:
 - a. 3/4 inch double wall assembly.
 - b. Reinforce interior of front panel with welded steel hat channels. Prepaint and sound deaden interior. Weld outer corners and grind smooth.
 - c. Secure hinges with screws to internal full-height reinforcing in case and door. Hinges shall be removable; welding of hinges is not acceptable.
 - d. Doors shall close against rubber bumpers.
- 6. Hinged Framed Glass Doors:
 - a. Frame: Outer head of one piece construction. Inner head consisting of top, bottom and side framing members removable for replacement of glass.
 - b. Glass: laminated safety glass.
 - c. Provide continuous vinyl glazing retainer to receive glass.
- D. Knee Space:
 - 1. Apron formed with channel shape at top and bottom, bottom front edge rounded to 3/4 inch radius, and openings for drawers where indicated, formed with rebate at top of opening. Where countertop is 30 inches above floor, provide clear knee space 27 inches high.
 - 2. Apron Division Cross Rails: steel C-channel at intervals not more than 30 inches on centers.
 - 3. Corner brackets flanged on top, bottom and sides, and welded to apron members.
 - 4. Corner top reinforcing gusset welded to top of apron
 - 5. Channel spreaders with 16 gage clip welded on for screw connection to legs.
 - 6. Back Panel: Minimum 18 gage steel. Provide all panels with bottom 6 inches fixed and the top portion removable.
- E. Filler Panels:
 - 1. Provide filler panels or scribe strips at exposed to view areas between back of cabinets and walls, between backs of cabinets at end of island or peninsula benches, and at any other area necessary to enclose gaps. For floor mounted cabinets provide all filler panels with bottom 6 inches fixed and the top portion removable.
 - 2. Grind edges and radius corners to eliminate sharp edges.
 - 3. Secure to frame and/or cabinet back and wall with metal angle and oval head screws with finishing washers

2.4 ADJUSTABLE SHELVING

- A. For nominal dimensions and general requirements refer to Section 123553.
- B. For Wall Frame Assemblies refer to Section 123553.
- C. Shelf Requirements:
 - 1. Metal shelving: Form front and back edges down 1 inch and returned back 3/4 inch. Form ends down 1 inch. Reinforce with a welded hat channel for the full length of the shelf.
 - 2. Provide with integral rear retaining lip 1 inch high. Top shelf assemblies do not require retaining lip.
 - 3. Provide with integral front retaining lip 1 inch high.

2.5 HARDWARE

- A. Refer to Section 123553.

2.6 METAL FINISH

- A. Refer to Section 123553.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to Section 123553.

END OF SECTION

SECTION 123553.19 – WOOD LABORATORY / ARTS CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes wood laboratory / arts casework.
- B. Related Requirements:
 - 1. Refer to Section 123553 "General Requirements for Laboratory / Arts Casework and Fume Hoods" for all References, Approved manufacturers, Materials, Hardware, Finishes, Installation, etc.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Refer to Section 123553 for approved manufacturers.

2.2 CASEWORK DESIGN

- A. Comply with SEFA 8-W "Laboratory Grade Wood Casework."
- B. Minimum standards for work within this Section: Construct in accordance with Premium Grade of the Architectural Woodwork Standards, latest edition unless otherwise specified herein.
- C. Full overlay style.
- D. Rigid and self-supporting cabinets suitable for use in an assembly or as individual, stand-alone units, with joints securely glued and cabinets clamped under pressure during assembly to ensure secure joints and cabinet squareness.
- E. Joints: Doweled and glued or mortised and tenoned secured with glue and countersunk screws.
- F. Square edged door and drawer fronts overlapping the openings on all four sides. In elevation, hold the reveal between end panel and door or drawer edge to a maximum of 1/8 inch wide. Hold spaces between abutting doors and drawers to a maximum of 1/8 inch wide, both horizontally and vertically, and shall be accurate and uniform, forming a continuous reveal throughout full length of assembled casework. Hold the reveal between top of cabinet and door or drawer edge to a maximum of 1/4 inch wide. Trim and sand smooth with all edges and corners radiused.
- G. Testing of Casework, Tables, and Shelving: Meet or exceed SEFA 8-W.

2.3 CASEWORK FABRICATION

- A. General: Include completely enclosed vertical posts. Include the items of cabinet construction listed. Exclude provisions for doors in open shelf cabinets or cubbies.
- B. Floor Mounted Base Cabinets:
 - 1. End Panels:
 - a. 3/4 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.

- c. Provide a minimum of 2 rows of drilled holes in each end panel, 1-1/4 inch on centers, for the attachment of drawer and shelf slides or shelf clips.
 - d. Attach to top frame, bottom, intermediate rails, and toespace rail with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
 - e. For sink cabinets containing an under-mount sink, provide support rails secured between end panels with leveling screws to support sink.
2. Backs:
 - a. Unexposed interiors and exteriors: Minimum 3/16 inch hardboard.
 - b. Exposed interiors and unexposed exteriors: 1/4 inch veneer core hardwood plywood.
 - c. Exposed exterior backs: 3/4 inch veneer core hardwood plywood.
 - d. Provide removable vertical split backs on all base cabinets, except units with security panels and sink cabinets, to allow access to service piping from the front of the unit.
 - e. All sink cabinets to have partial height back panels to allow passage of the drain line and piping to the service chase.
3. Bottoms:
 - a. 3/4 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.
 - c. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
4. Toespace Rail:
 - a. Install between end panels to provide a minimum toespace of 2-1/4 inches deep by 4 inches high.
 - b. Type 2 hardwood lumber or fir, 3/4 inch by 4 inch.
5. Top Frames:
 - a. Full frame consisting of front, rear, and side members. Join frame members with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
 - b. Front member: Type 1 hardwood lumber or Type 2 hardwood lumber with 1/8 inch), Type 1 hardwood lumber edgebanding. Minimum 1 inch by 2-1/2 inch.
 - c. Rear member: Type 1 or Type 2 hardwood lumber. Minimum 1 inch by 2-1/2 inches.
 - d. Side members: Type 2 hardwood lumber. Minimum 3/4 inch by 1-1/2 inch.
 - e. Attach top frame to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
6. Intermediate Rails: Provide between drawers and doors, and between multiple drawers at all security panels.
 - a. Type 1 hardwood lumber, minimum 3/4 inch thick.
 - b. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
7. Security Panels:
 - a. 1/4 inch thick medium density fiberboard let into intermediate rails.
 - b. Provide on all base cabinets with locks, between drawers and door, and between drawers.
8. Vertical Dividers:
 - a. 1-1/2 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch. Type 1 hardwood lumber edgebanding.
 - c. Attach to bottom, front top rail, and rear top rail with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
9. Adjustable Pullout Shelves:
 - a. Shelf: 3/4 inch veneer core hardwood plywood.
 - b. Retaining lip: Provide all around shelf, 2 inches above shelf surfaces, using 2-3/4 inch by 1/2 inch 9 ply Baltic birch veneer core hardwood plywood or 1/2 inch Type 2 hardwood lumber.
 - c. Adjustable on 1-1/4 inch centers.

- d. Front edge of shelf to be within 1 inch of inside face of door.
 - e. Pullout shelves to fully extend with doors open at minimum of 90 degrees.
10. Adjustable Shelves:
- a. Provide one shelf per cupboard unit. 1 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.
 - c. Fit dividers and end panels with stud type shelf brackets for adjustment on 1-1/4 inch centers. Groove shelves at brackets to prevent movement.
 - d. Front edge of shelf to be within 1 inch of inside face of door. Provide split-depth shelf so that front section can be removed to allow for taller storage.
11. Hinged Doors: 3/4 inch hardwood plywood with particleboard, MDF or combination core with 1/8 inch, Type 1 hardwood lumber edgebanding.
12. Drawers:
- a. Drawer box (back, sides, and subfront): Minimum 1/2 inch 9 ply Baltic Birch veneer core plywood or 1/2 inch, Type 2 hardwood. Attach back, subfront and sides with 5/16 inch dowels and glue or multiple dovetail and glue.
 - b. Bottom: 1/4 inch hardboard. Dado bottom into back, subfront and sides sealed with hot melt glue around drawer bottom perimeter.
 - c. Removable drawer head: 3/4 inch hardwood plywood with particleboard, MDF or combination core with 1/8 inch Type 1 hardwood lumber edgebanding.
13. Pull-out Tablet:
- a. Pull-out tablet front: 3/4 inch hardwood plywood with particleboard, MDF or combination core with 1/8 inch, Type 1 hardwood lumber edgebanding on all edges.
 - b. Tablet body: 3/4 inch hardwood plywood, particleboard, MDF or combination core. Grade VGP plastic laminate on both surfaces. 1/8 inch PVC edgebanding on all edges.
 - c. Tablet slides: Accuride Model #2109 keyboard slide with hold-in/hold-out detent and clear zinc finish.
- C. Wall and Upper Cabinets:
1. End Panels:
- a. 3/4 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch Type 1 hardwood lumber edgebanding.
 - c. Provide 2 rows of drilled holes in each end panel, 1-1/4 inch on centers, to receive shelf clips.
 - d. Attach to top, bottom, and bottom rail with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
2. Backs:
- a. 1/4 inch veneer core hardwood plywood.
 - b. Rabbetted backs and provide unexposed exterior hanger rails at the top and the bottom.
3. Bottoms:
- a. 1 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.
 - c. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
4. Tops:
- a. 1 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.
 - c. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
5. Adjustable Shelves:
- a. Full width with one adjustable shelf for cabinets up to 30 inches high.

- b. 1 inch veneer core hardwood plywood.
 - c. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.
 - d. Adjustable on 1-1/4 inch centers.
 - e. Front edge of shelf to be within 1 inch of inside face of door.
6. Hinged Solid Doors: 3/4 inch hardwood plywood with particleboard, MDF or combination core with 1/8 inch, Type 1 hardwood lumber edgebanding.
7. Hinged Framed Glass Doors:
- a. Frame: Minimum 3/4 inch by 2-3/4 inch, Type 1 hardwood lumber.
 - b. Glass: Tempered safety glass.
 - c. Assemble frame with mortise and tenon joints secured with glue.
 - d. Provide extruded vinyl retaining molding designed so glass can be replaced without tools.
- D. Tall Cabinets:
1. End Panels:
- a. 3/4 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch Type 1 hardwood lumber edgebanding.
 - c. Provide 2 rows of drilled holes in each end panel, 1-1/4 inch on centers, to receive shelf clips.
 - d. Attach to top, bottom, and bottom rail with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
2. Backs: 1/4 inch veneer core hardwood plywood.
3. Bottoms:
- a. 3/4 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.
 - c. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
4. Bottom Toe Space:
- a. 3/4 inch by minimum 4 inch, Type 1 hardwood lumber or fir.
 - b. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
5. Tops:
- a. 1 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.
 - c. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
6. Fixed and Adjustable Shelves:
- a. 1 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch, Type 1 hardwood lumber edgebanding.
 - c. Provide five full width shelves. Center shelf to be fixed by attaching to end panels with doweled and glue or mortise and tenon joints secured with glue and countersunk screws. Four shelves to be adjustable.
 - d. Adjustable on 1-1/4 inch centers.
 - e. Front edge of shelf to be within 1 inch of inside face of door.
7. Hinged Solid Doors: 3/4 inch hardwood plywood with particleboard, MDF or combination core with 1/8 inch, Type 1 hardwood lumber edgebanding.
8. Hinged Framed Glass Doors:
- a. Frame: Minimum 3/4 inch by 2-3/4 inch, Type 1 hardwood lumber.
 - b. Glass: laminated safety glass.
 - c. Assemble frame with mortise and tenon joints secured with glue.
 - d. Provide extruded vinyl retaining molding designed so glass can be replaced without tools.

- E. Tall Cabinets, Double Height Art Canvas Storage (T30Sk): Provide tall canvas storage as detailed on the drawings and as described under Tall Cabinets above, unless modified under this Paragraph:
1. Horizontal Framing:
 - a. Provide top, middle and bottom frame members secured to vertical supports with glue and countersunk screws.
 - b. Type 2 hardwood lumber or fir, 1 inch (19 mm) by 4 inch
 2. Backs: 3/4 inch (6 mm) veneer core hardwood plywood.
 3. Fixed Shelves:
 - a. Shelves to be fixed by attaching to end panels or vertical dividers with dowel and glue or mortise and tenon joints secured with glue and countersunk screws.
 4. Vertical Dividers:
 - a. 3/4 inch veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch Type 1 hardwood lumber edgebanding.
 - c. Attach to top and bottom with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
- F. Tall Cabinets, Full Height Art Canvas Storage (T45S): Provide tall canvas storage as detailed on the drawings and as described under this Paragraph:
1. Bottoms:
 - a. 1 inch (19 mm) veneer core hardwood plywood.
 - b. Exposed edges: 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.
 - c. Attach to toe space rails with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
 2. Toespace Rail:
 - a. Install to provide a minimum toespace of 2-1/4 inches (57 mm) deep by 4 inches (100 mm) high.
 - b. Type 2 hardwood lumber or fir, 2 inch (19 mm) by 4 inch (100 mm).
 3. Horizontal Framing:
 - a. Provide top, middle and bottom frame members secured to vertical supports with glue and countersunk screws.
 - b. Type 2 hardwood lumber or fir, 1 inch (19 mm) by 4 inch.
 4. Vertical Support:
 - a. Type 2 hardwood lumber or fir, 2 inch (19 mm) by 6 inch secured to horizontal members with glue and countersunk screws.
 5. Diagonal Framing:
 - a. Type 2 hardwood lumber or fir, 2 inch (19 mm) by 4 inch (19 mm) secured to vertical support and bottom with glue and countersunk screws.
 - b. (3 mm) Provide on vertical support at each end.
 - c. Provide on every fourth vertical support.
- G. Tall Cabinets, Open Shelving: Provide tall cabinet, as described under Tall Cabinets above, unless modified under this Paragraph:
1. Provide without doors.
- H. Knee Space:

1. Perimeter Rails: 3/4 inch by 4-1/8 inches solid Type 1 hardwood lumber. Groove rails for "Z" irons or drill for top attachment. Front rail forms apron.
2. Reinforcing Cross Rails: 3/4 inch by 4-1/8 inches solid hardwood lumber glued into front and back rail grooves and pinned at intervals not more than 33 inches on centers. Reinforce cross rails with glue blocks.
3. Leg: 2 inch by 2 inch solid, Type 1 hardwood lumber. Provide legs with leveling glides and a 4 inch high black coved vinyl or rubber shoe around leg base.
4. Leg stretcher rails with 1-1/4 inch by 2-1/2 inch solid Type 1 hardwood lumber. Connect by mortise and tenon and stove type bolt, washer and square nut.
5. Cantilevered or Gabled Leg Panel: 1-1/2 inch thick cantilevered veneer core hardwood plywood member with Type 1 hardwood lumber edgebanding.
6. Back Panel: 3/8 inch veneer core hardwood plywood with 1/8 Type 1 hardwood lumber edgebanding. Provide all panels with bottom 6 inches fixed and the top portion removable. Attach removable portion using stainless steel screws and finishing washers.

I. Filler Panels:

1. Provide filler panels or scribe strips at exposed to view areas between back of cabinets and walls, between backs of cabinets at end of island or peninsula benches, and at any other area necessary to enclose gaps. When cabinets abut side walls, provide a 1 inch filler panel between side of cabinet and wall. For floor mounted cabinets, the filler panel is to include a toe kick to match casework For floor mounted cabinets provide all filler panels with bottom 6 inches fixed and the top portion removable.
2. 3/8 inch veneer core hardwood plywood with 1/8 inch, Type 1 hardwood lumber edgebanding.
3. Secure to frame and/or cabinet back and wall with metal angle and oval head screws with finishing washers.

2.4 ADJUSTABLE SHELVING

- A. For nominal dimensions and general requirements refer to Section 123553.
- B. For Wall Frame Assemblies refer to Section 123553.
- C. For Adjustable Island and Peninsula Bench Shelving Assemblies refer to Section 123553.
- D. Shelf Requirements:
 1. Wood shelving: 1 inch thick veneer core hardwood plywood with a maximum span of 48 inches. Provide 1/8 inch Type 1 hardwood lumber edgebanding on all edges.
 2. Provide with rear retaining lip 1/2 inch thick by 2 inch high, Type 1 hardwood lumber attached to rear edge of shelving with screws, maximum 12 inches on center. Top shelf assemblies do not require retaining lip.

2.5 HARDWARE AND METAL FINISH

- A. Refer to Section 123553.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to Section 123553.

END OF SECTION

SECTION 123553.26 – SOLID PHENOLIC RESIN PHOTOGRAPHY CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Work required for this section includes solid phenolic resin laboratory casework with supplementary items necessary to complete their installation:
 - 1. Photography Casework.
 - a. Room 15101
 - b. Room 15101A
 - c. Room 15101B
- B. Related Requirements:
 - 1. Refer to Section 123553 General Requirements for Laboratory / Arts Casework and Fume Hoods for References, Submittal Requirements, Quality Assurance, Work Surface Materials, Hardware, Finishes, Installation, etc.

1.2 REFERENCES

- A. Refer to Section 123553.

PART 2 - PRODUCTS

2.1 MANUFACTURERS OF RAW PHENOLIC RESIN PANEL PRODUCTS

- A. Acceptable Manufacturers and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures".
 - 1. Durcon, a Wilsonart Company.
 - 2. Fundermax North America, Inc.
 - 3. Trespa North America, Ltd.
 - 4. Or approved equal.
- B. All panel products specified in this section shall be provided by a single manufacturer.

2.2 FABRICATORS OF PHENOLIC RESIN CASEWORK

- A. Acceptable Fabricators: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section "Substitution Procedures".
 - 1. Mott Manufacturing Limited.
 - 2. PerMar, Ltd.
 - 3. SSI Surfaces, Inc.
- B. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
 - 1. SSI Surfaces, Inc.

- C. Furnish and install casework, photo processing sinks, furnishings and equipment specified in the following sections by the same supplier.
1. 112183 Photo Processing Sinks
 2. 123553 General Requirements for Laboratory / Arts Casework and Fume Hoods.
 3. 123553.26 Solid Phenolic Resin Laboratory Casework.

2.3 PANEL PERFORMANCE REQUIREMENTS

- A. Thickness: Solid phenolic material shall have uniform thickness 0.03 inch and flatness of maximum difference of 0.03 inch for 10 foot span.
- B. Listing: Panels shall be U.L. registered and labeled for quality consistency.
- C. Panels to have screw pull-out strength minimums per following chart (lbs.):

Screw Depth	#6	#8	#10	#12	1/4"	5/16"	3/8"	7/16"	1/2"
1/4" panels	120	150	170	200	230				
5/16" panels	160	190	210	240	280	350			
3/8" panels	190	220	260	290	340	420	510		
1/2" panels	250	300	340	390	450	560	680	790	900
5/8" panels	310	370	430	490	560	710	850	990	1000
3/4" panels			510	590	680	850	1000	1200	1400

- D. Uniform load to cause no more than 1/4 inch deflection at center of the span:

Thickness	12" x 24"	12" x 36"	12" x 48"	24" x 36"
1/4" panels	35	10	5	20
5/16" panels	85	25	10	50
3/8" panels	170	50	20	100
1/2" panels	370	110	45	220
5/8" panels	690	210	85	410
3/4" panels	1400	400	170	800
1" panels	2600	780	330	1500

- E. Performance Requirements:
1. Modulus of elasticity: 1,500,000 psi minimum.
 2. Shear strength: 2000 psi minimum.
 3. Compressive strength: 24,000 psi minimum.
 4. Weight: 93 lbs. per cubic foot maximum.
 5. Flame spread (ASTM E-84): Class 1A.
 6. Non-porous surface and edges.
 7. Will not support micro-organic growth.

2.4 CASEWORK DESIGN

- A. Comply with SEFA 8-PH "Laboratory Grade Phenolic Casework."
- B. Flush overlay style: Square edged door and drawer fronts overlapping the openings on all four sides. In elevation, hold the reveal between end panel and door or drawer edge to a maximum of 1/8 inch wide. Hold spaces between abutting doors and drawers to a maximum of 1/8 inch wide, both horizontally and vertically, and shall be accurate and uniform, forming a continuous reveal throughout full length of assembled casework. Hold the reveal between top of cabinet and door or drawer edge to a maximum of 1/4 inch wide.

- C. Each cabinet to be assembled incorporating mortise and tendon construction or 1-1/2 inch dowel construction. Vertical and horizontal members shall be keyed and phenol seal bonded and mechanically fastened. Exposed edges on cabinet components, doors and drawer heads shall be sanded and polished to a satin smooth finish. Underside of toe space shall be enclosed.
- D. Self-Supporting Units: Completely welded shell assembly without applied panels at ends, backs or bottoms, so that cases can be used interchangeably or as a single, stand-alone unit.
- E. Interior of Case Units: Easily cleanable, flush interior. Base cabinets, 30 inches and wider, with double swinging doors shall provide full access to complete interior without center vertical post.
- F. Drawers: Sized on a modular basis for interchange to meet varying storage needs, and designed to be easily removable in field without the use of special tools.
- G. Testing of Casework and Shelving: Meet or exceed SEFA 8.

2.5 CASEWORK FABRICATION

A. General:

1. Component Thickness Schedule:

Cabinet sides and bottoms	1/2 inch (13 mm)
Door and drawer fronts	1/2 inch (13 mm)
Drawer body: front, sides and backs	1/2 inch (13 mm)
Drawer bottoms	1/4 inch (6 mm)
Horizontal rail supports	1/2 inch (13 mm)
Cabinet backs, access panels, filler panels	1/4 inch (6 mm)
Shelves up to 30 inches wide	3/4 inch (20 mm)
Shelves greater than 30 inches	1 inch (25 mm)
Wall and tall cabinet tops and bottoms	3/4 inch (20 mm)

B. Floor Mounted Base Cabinets:

- 1. Sectional units, cabinets and cases shall be located on the laboratory floor and shall be equipped with leveling devices that are easily adjustable, to compensate for unevenness in the floor.
- 2. Sectional units shall have 4 inches high by 3 inches deep toe space members.
- 3. Adjustable Shelves: All shelves shall be adjustable on 1-1/2 inch centers.
- 4. Intermediate Rails: Provide between doors and drawers and between drawers at all security panels. Recessed behind doors and drawer fronts.
- 5. Backs: Provide a removable access panel on the back of the case for access to utilities. All access panels shall be sized to permit reasonable chase access and are removable from inside of the case without the use of tools. Open backed cases are not acceptable, except at sink cabinets.
- 6. All sink cabinets to have partial height back panels to allow passage of drain line and piping to service chase.
- 7. Security Panels: Provide on all base cabinets with locks, between drawers and door, and between drawers.
- 8. Hinged Doors: Secure hinges with screws to internal case and door. Doors shall close against rubber bumpers.
- 9. Drawers:
 - a. Drawer front: Drawer fronts shall be attached to drawer box using dual directional adjustment hardware.
 - b. Drawer body: Drawers shall have full box construction. Sides shall be full height with 1/2 inch clearance to frame opening. Drawers shall be a minimum of 18 inches front to back.
 - c. Drawer bottoms: Set into sub-front, back and sides of drawers with hot glue around entire perimeter.
 - d. Drawers shall close against rubber bumpers.

- e. Provide light tight covers at all drawers in 15101A Darkroom and 15101B Film.
 - 1) Light tight covers with passive operation requiring no action on operator's part to maintain light tight integrity. Design light tight drawers to be incapable of being left in a position which defeats light tight protection, including when drawer is in the fully extended open position.

- C. Wall and Upper Cabinets:
 - 1. Sectional units consisting of cabinet sides, back, top and bottom members.
 - 2. Adjustable Shelves:
 - a. Full width with one adjustable shelf
 - b. Adjustable on 1/2 inch centers
 - c. Front edge of shelf to be within 1 inch (25 mm) of front edge of cabinet.
 - 3. Hinged Doors: Secure hinges with screws to internal case and door. Doors shall close against rubber bumpers.

- D. Tall Cabinets: Construct according to the specifications set forth for base cabinets except as modified within this paragraph.
 - 1. Tops: Provide one piece on each tall unit.
 - 2. Backs: Provide one piece fixed back on each tall unit.
 - 3. Fixed and Adjustable Shelves:
 - a. Provide five full width shelves. Center shelf to be fixed by attaching to end panels. Four shelves to be adjustable on 1/2 inch centers.
 - b. Front edge of shelf to be within 1 inch of front edge of cabinet.
 - c. Hinged Framed Glass Doors: Frame: One piece construction. Provide continuous vinyl glazing retainer to receive glass.
 - d. Glass: tempered safety glass.

- E. Enlarger Stations: Construct according to the specifications set forth for base and tall cabinets except as modified within this paragraph.
 - 1. Cabinet backs are full height. Cabinet sides are full height and shaped as indicated on the drawings.
 - 2. Provide bench top full width of enlarger station with grommet as indicated on the drawings.
 - 3. Fixed Shelf:
 - a. Provide full width shelf between cabinet sides.
 - b. Front edge of shelf to be within 1 inch (25 mm) of front edge of bench top.
 - 4. Drawers: Provide light tight covers.

- F. Knee Space:
 - 1. Apron: 4 inches by full width strip shall be attached to the countertop at the front of the knee space. Provide clear knee space 27 inches high.
 - 2. Back Panel: rear closure panels shall be the full height and width under the countertop. The knee space shall provide an access panel to the chase area.

- G. Filler Panels:
 - 1. Provide filler panels or scribe strips at exposed to view areas between back of cabinets and walls, between backs of cabinets at end of island or peninsula benches, and at any other area necessary to enclose gaps. When cabinets abut side walls, provide a 1 inch filler panel between side of cabinet and wall. For floor mounted cabinets, the filler panel is to include a toe kick to match casework. For floor mounted cabinets provide all filler panels with bottom 6 inches fixed and the top portion removable.

2.6 HARDWARE

- A. Refer to Section 123553.

2.7 ADJUSTABLE SHELVING

- A. For nominal dimensions and general requirements refer to Section 123553.
- B. For Wall Assemblies refer to Section 123553.
- C. Shelf Requirements:
 - 1. Provide in lengths as indicated on the drawings.

2.8 WORK SURFACES

- A. Refer to Section 123553.

2.9 SINKS

- A. Refer to Section 123553.

2.10 LABORATORY SERVICE FIXTURES

- A. Refer to Section 123553.

2.11 SOURCE QUALITY CONTROL TESTING OF SOLID PHENOLIC RESIN CABINET SURFACES

- A. Phenolic Finish: Meet or exceed the latest edition of the following Section and Articles of SEFA-8-PH Recommended Practices:
 - 1. 8.0 Cabinet Surface Finish Test:
 - a. 8.1 Chemical Spot Test.
 - b. 8.2 Hot Water Test.
- B. Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor.
- C. Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the above SEFA-8-PH Recommended Practices.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to Section 123553.

END OF SECTION

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Solid surface material countertops.
 - 2. Solid surface material backsplashes and endsplashes.
- B. Related Requirements:
 - 1. Division 22 for Plumbing Fixtures" for sinks and plumbing fittings.

1.2 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches square.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Provide the following upon request:
 - 1. Qualification Data: For fabricator.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.6 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avonite Surfaces.
 - b. E. I. du Pont de Nemours and Company.
 - c. Formica Corporation.
 - d. LG-HAUSYS/HI-MACS
 - e. Wilsonart LLC.
 - 2. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated on Drawings, or Architect approved equal.
 - 3. Special Warranty Period: 10 years from Date of Substantial Completion.
- B. Colors and Patterns: As indicated; refer to Finish Schedule on the Drawings.
- C. Subtops: Exterior softwood plywood complying with DOC PS1, Grade C-C Plugged, touch sanded. Use marine grade plywood at countertops with sinks.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the "Architectural Woodwork Institute (AWI) Standards."
 - 1. Grade: Premium.
- B. Configuration: For design purposes, slightly eased shall mean 1/16 inch chamfer, to be verified in Shop Drawing review.
 - 1. Front: Straight, slightly eased at top as detailed.
 - 2. Backsplashes and Endsplashes: Straight, slightly eased at corner. For design purposes, slightly eased shall mean 1/16 inch chamfer, to be verified in Shop Drawing review.
- C. Thickness: As indicated, refer to Finish Schedule on the Drawings.
- D. Comply with solid surfacing material manufacturer's written instructions for adhesives, fabrication, and finishing.
- E. Joints: Fabricate countertops without joints to greatest extent possible. If joints are unavoidable, fabricate countertops in sections for joining in field, with joints at locations indicated on approved Shop Drawings.
 - 1. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
- F. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
 - 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 ACCESSORIES

- A. Color: As selected by Architect.
- B. Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Rangine Corporation.
 2. Basis-of-Design Product: Rakks Inside Wall Mount EH Counter Support Bracket.
 3. Size: As recommended by manufacturer for counter depths indicated.
 4. Finish: Primed for field painting.
 5. Basis-of-Design Product: ADA Compliant Vanity Support Bracket.
 6. Size: Designed to support counters up to 24 inches deep.
 7. Finish: Mill.

2.4 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by quartz agglomerate manufacturer.
 1. Adhesives shall have a VOC content of 70 g/L or less.
 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Sealant for Countertops: Comply with applicable requirements for mildew-resistant sealants in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed difference between planes of adjacent units as allowed by AWI Standard grade indicated.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

- E. When joints are unavoidable, bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Countertop Support Brackets:
 - 1. Install miscellaneous metal support brackets as indicated in approved Shop drawings or provide manufactured support brackets in accordance with manufacturer's written instructions.
 - 2. Install brackets at locations and heights indicated on Drawings.
 - 3. Install brackets rigidly to supporting substrate so that they are secure, plumb, and aligned.
- H. Where aprons are indicated, install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Pre-drill holes for screws as recommended by manufacturer.
- I. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- J. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION

SECTION 142123.16 - MACHINE ROOM-LESS ELECTRIC TRACTION PASSENGER ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes machine-room-less electric traction elevators.
- B. Related Requirements:
 - 1. Section 015000 "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
 - 2. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
 - 3. Section 051200 "Structural Steel Framing" for the following:
 - a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - 4. Section 055000 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Structural-steel shapes for subsills and hoistway entrance support.
 - c. Pit ladders.
 - d. Cants made from steel sheet in hoistways.
 - 5. Division 27 Section for "Communications Copper Horizontal Cabling" for twisted pair cable for telephone service for elevators and for connection to elevator controllers for remote monitoring of elevator performance.
 - 6. Division 28 Section for "Addressable Fire-Alarm Systems" for smoke detectors in elevator lobbies to initiate emergency recall operation, for heat detectors in shafts and machine rooms to disconnect power from elevator equipment before or on sprinkler activation, and for connection to elevator controllers.

1.2 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

1.3 ACTION SUBMITTALS

- A. Product Data: For each product.
 - 1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
 - 2. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal systems.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
 - 2. Include large-scale layout of car-control station and standby power operation control panel.
 - 3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- C. Samples for Initial Selection: For each type of exposed finish involving color selection.

- D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch-square Samples of sheet materials; and 4-inch lengths of running trim members.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
 - 1. Submit manufacturer's or Installer's standard operation and maintenance manual, in accordance with ASME A17.1/CSA B44 including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.
- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.
- B. Provide the following upon request:
 - 1. Qualification Data: For Installer.
 - 2. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 3. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway and pit layout and dimensions, as indicated on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.7 COORDINATION

- A. Coordinate installation of inserts, sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, inserts, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate locations and dimensions of work specified in other Sections that relates to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways and pits.

1.8 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC A117.1 as amended by CBC Chapter 11B.
- C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7 and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.
 - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 - 2. Project Seismic Design Category: D E F.
 - 3. Elevator Component Importance Factor: 1.5.
 - 4. Provide earthquake equipment required by ASME A17.1/CSA B44.
 - 5. Provide seismic switch required by ASCE/SEI 7.

2.2 MACHINE-ROOM-LESS ELECTRIC TRACTION ELEVATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. KONE Inc.
 - 2. Otis Worldwide Corporation.
 - 3. Schindler Elevator Corp.
 - 4. ThyssenKrupp Elevator.
- B. Basis-of-Design Product: Otis Gen3 Edge
- C. Source Limitations: Obtain elevators from single manufacturer.
 - 1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.
- D. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.
- E. Elevator Description:
 - 1. Elevator Number(s): 1.
 - 2. Rated Load: 3500 lb.
 - 3. Rated Speed: 200 fpm .

4. Operation System: Selective-collective automatic operation.
5. Auxiliary Operations:
 - a. Standby power operation.
 - b. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44.
 - c. Automatic dispatching of loaded car.
 - d. Nuisance-call cancel.
 - e. Off-peak operation.
 - f. Automatic operation of lights and ventilation fans.
6. Security Features: Keyswitch operation.
7. Car Enclosures:
 - a. Inside Width: Not less than 77 inches from side wall to side wall.
 - b. Inside Depth: Not less than 65 inches from back wall to front wall (return panels).
 - c. Inside Height: Not less than 93 inches to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, ASTM A480/A480M, No. 4 finish .
 - e. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - f. Side and Rear Wall Panels: Satin stainless steel, ASTM A480/480M, No. 4 finish.
 - g. Reveals: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - h. Door Faces (Interior): Satin stainless steel, ASTM A480/A480M, No. 4 finish .
 - i. Door Sills: Aluminum.
 - j. Ceiling: Satin stainless steel, ASTM A480/A480M, No. 4 finish .
 - k. Handrails: 1/2 by 2 inches rectangular, satin stainless steel flat bar at rear of car.
8. Hoistway Entrances:
 - a. Width: 42 inches.
 - b. Height: 84 inches.
 - c. Type: Single-speed side sliding .
 - d. Frames : Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - e. Doors : Satin stainless steel, ASTM A480/A480M, No. 4 finish .
 - f. Sills : Aluminum.
9. Hall Fixtures : Satin stainless steel, ASTM A480/A480M, No. 4 finish .
10. Additional Requirements:
 - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, ASTM A480/A480M, No. 4 finish.

2.3 TRACTION SYSTEMS

- A. Elevator Machines: Permanent magnet, variable-voltage, variable-frequency, ac-type hoisting machines and solid-state power converters.
 1. Provide regenerative system.
 2. Limit total harmonic distortion of regenerated power to 5 percent in accordance with IEEE 519.
 3. Provide means for absorbing regenerated power when elevator system is operating on standby power.
 4. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.
- B. Fluid for Hydraulic Buffers: Fire-resistant fluid.
- C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- D. Machine Beams: Provide steel framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 055000 "Metal Fabrications" for materials and fabrication.
- E. Car Frame and Platform: Bolted- or welded-steel units.

- F. Guides: Roller guides or polymer-coated, nonlubricated sliding guides. Provide guides at top and bottom of car and counterweight frames.

2.4 OPERATION SYSTEMS

- A. Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.
- B. Auxiliary Operations:
 - 1. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby. Manual operation causes automatic operation to cease.
 - 2. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
 - 3. Nuisance-Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.
 - 4. Off-Peak Operation: During periods of low traffic, half of the elevators in a group shall be taken out of service and switched to sleep, low power mode.
 - 5. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after five minutes and are re-energized before car doors open.
 - 6. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.
- C. Security features shall not affect emergency firefighters' service.
 - 1. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car-control stations and hall push-button stations. Key is removable only in deactivated position.
 - 2. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes car to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.5 DOOR REOPENING DEVICES

- A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.6 CAR ENCLOSURES

- A. Provide steel-framed car enclosures with nonremovable wall panels, with removable car roof, access doors, power door operators, and ventilation.
 - 1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
 - 1. Subfloor:
 - a. Exterior, underlayment grade plywood, not less than 5/8-inch nominal thickness.

2. Floor Finish: As indicated.
3. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.
4. Fabricate car with recesses and cutouts for signal equipment.
5. Fabricate car door frame integrally with front wall of car.
6. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet .
7. Sight Guards: Provide sight guards on car doors.
8. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
9. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
10. Ceiling: Metal flush panels, with four low-voltage downlights in each panel. Align ceiling panel joints with joints between wall panels.
11. Light Fixture Efficiency: Not less than 35 lumens/W.
12. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

2.7 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.
 1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible in accordance with NFPA 252 or UL 10B.
 1. Fire-Protection Rating: 1-1/2 hours.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 1. Stainless Steel Frames: Formed from stainless steel sheet.
 2. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet.
 3. Sight Guards: Provide sight guards on doors matching door edges.
 4. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
 5. Strut Angles: Provide strut angles extending from sill to beam above and securely anchored to building construction for support of hoistway entrances. Fastenings and bracing shall be corrosion resistant.
 6. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.8 SIGNAL EQUIPMENT

- A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide vandal-resistant buttons and lighted elements illuminated with LEDs.
- B. Car-Control Stations: Provide manufacturer's standard recessed or semirecessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.
 1. Mark buttons and switches for function. Use both tactile symbols and Braille.

2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
- E. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Section 284621.11 "Addressable Fire-Alarm Systems."
- F. Car Position Indicator: Provide digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
- G. Hall Push-Button Stations: Provide one hall push-button station at each landing Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group Provide hall push-button stations at each landing as indicated.
 1. Provide manufacturer's standard wall-mounted units.
 2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
 - a. Provide for connecting units to building security access system so a card reader can be used to register calls.
 3. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Section 284621.11 "Addressable Fire-Alarm Systems."
- H. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:
 1. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
- I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
 1. At manufacturer's option, audible signals may be placed on cars.
- J. Hall Position Indicators: Provide illuminated, digital-display-type position indicators, located above each hoistway entrance at ground floor. Provide units with flat faceplate and with body of unit recessed in wall.
 1. Integrate ground-floor hall lanterns with hall position indicators.
- K. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed.
- L. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
- M. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.9 FINISH MATERIALS

- A. Stainless Steel Sheet: ASTM A240/A240M, Type 304.
- B. Stainless Steel Bars: ASTM A276/A276M, Type 304.
- C. Stainless Steel Tubing: ASTM A554, Grade MT 304.
- D. Aluminum Extrusions: ASTM B221/, Alloy 6063.
- E. Plastic Laminate: High-pressure type complying with ISO 4586-3, Type HGS for flat applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, and pits as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MACHINE-ROOM-LESS ELECTRIC TRACTION ELEVATORS

- A. Comply with manufacturer's written instructions.
- B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
- E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- F. Leveling Tolerance: 1/8 inch, up or down, regardless of load and travel direction.
- G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- H. Locate hall signal equipment for elevators as follows unless otherwise indicated:
 - 1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
 - 2. Place hall lanterns either above or beside each hoistway entrance.
 - 3. Mount hall lanterns at a minimum of 72 inches above finished floor.

- I. Provide guarding of counterweight in a multiple-elevator hoistway as required. When a counterweight is located between elevators, the counterweight runway shall be guarded on the side next to the adjacent elevator. The guarding shall meet or exceed the requirements of ASME A17.1/CSA B44, latest applicable code year, section 2.3.2.3. If an emergency door in a blind hoistway is required, provide an outward swinging single section type door with door closer and a self-closing barrier in accordance with ASME A17.1/CDS B44, latest applicable code year, section 2.11.1.2.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Operating Test: Load each elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
- C. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

- A. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for elevator used for construction purposes:
 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 2. Provide strippable protective film on entrance and car doors and frames.
 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 5. Do not load elevators beyond their rated weight capacity.
 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
- B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.6 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 1. Perform maintenance during normal working hours.

2. Perform emergency callback service during normal working hours with response time of two hours or less.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.

END OF SECTION 142123.16

SECTION 211300 - FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Furnish all new materials and labor for the detailed design and installation of new automatic fire sprinkler systems as outlined in Design Drawings, hereafter referred to as the "Systems" in complete compliance with this Specification, Contract Drawings, and all applicable codes and standards.
- B. Contract drawings are for information only to show potential system arrangement. Contractor shall field verify all site conditions and information contained on the contract drawings and is responsible for the complete design and installation of the systems in accordance with the specifications. The contract drawings are intended to be provided to DSA for review and approval. These drawings will be coordinated with the contractor once the design is completed to develop as-built documents. The contract drawings may not show all information necessary for installation of the systems but are intended to be used by Contractor for the purpose of preparing a bid. The contract drawings indicate the following:
 - 1. Approximate pipe routing and sizes.
 - 2. Location of the new riser(s) for the Systems, and major points on the system, such as the fire department connection(s).
- C. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Sprinklers.
 - 4. Alarm devices.
 - 5. Pressure gauges.
 - 6. Identification signs.
 - 7. Escutcheons.
 - 8. Floor plates.
 - 9. Sleeves.
 - 10. Stack-sleeve fittings.
 - 11. Sleeve-seal systems.
 - 12. Sleeve-seal fittings.
- D. Related Requirements:
 - 1. All Division 1 specification sections.
 - 2. Section 283111 "Digital Addressable Fire Alarm System."

1.2 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at a maximum working pressure of 175 psig.
- B. AHJ: Authority Having Jurisdiction.
- C. FM: Factory Mutual Global.
- D. UL: Underwriters Laboratories.

1.3 INTENT OF SPECIFICATION

- A. The work performed pursuant to these specifications is to be complete in every respect, resulting in the Systems installed in accordance with the applicable codes, standards, manufacturers' recommendations, and UL listings.

- B. Commencement of Work:
 - 1. No work shall be performed until shop drawings, calculations, and data sheets have been approved by Architect and Engineer. The contractor is solely liable for any work performed prior to this approval.
- C. Upon completion of this work, and as a part of this contract, provide Owner with:
 - 1. Complete information and "as-built" record drawings describing and depicting the entire system as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system at a future date.
 - 2. Complete documentation of system testing in accordance with NFPA 13 and AHJ's acceptance.
 - 3. Certification that Contractor's work has been inspected and tested, is installed entirely in accordance with the applicable codes, standards, manufacturers' recommendations and UL listings and is in proper working order. Contractor shall use "Contractor's Material and Test Certificate(s)" as required by NFPA 13.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to the water supply through an alarm valve. Water discharges immediately from sprinklers when they operate. Automatic sprinklers operate when heat melts fusible link or destroys frangible device.

1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design sprinkler systems, including comprehensive engineering analysis by a qualified design professional, using performance requirements and design criteria indicated. Refer to Section 013573 for design requirements and procedures associated with delegated design.
- B. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.5.
- C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- D. Available fire-hydrant flow test records indicate the following conditions:
 - 1. Date: May 17, 2024.
 - 2. Time: 9:30 a.m.
 - 3. Performed by: Michael Kuykendall of Sandis.
 - 4. Location of Residual Fire Hydrant R: Hydrant A.
 - 5. Location of Flow Fire Hydrant F: Hydrant B.
 - 6. Static Pressure at Residual Fire Hydrant R: 110 psig.
 - 7. Measured Flow at Flow Fire Hydrant F: 1,400 gpm.
 - 8. Residual Pressure at Residual Fire Hydrant R: 84 psig.
- E. Sprinkler system design shall be approved by authorities having jurisdiction.
- F. Margin of Safety:
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent of the minimum required residual pressure or 10 psig, whichever is greater, including losses through water-service piping, valves, and backflow preventers.

- G. Sprinkler Occupancy Hazard Classifications and Design Criteria: Design systems in accordance with NFPA 13 and the criteria indicated in these specifications and drawings.
1. Light Hazard:
 - a. Definition: Occupancies where the quantity and combustibility of content are low and fire with relatively low rates of heat release are expected.
 - b. Examples:
 - 1) Office and public areas.
 - 2) Educational areas.
 - c. Minimum Design Area and Design Density: 0.10 gpm/sq. ft. over 1500-sq. ft. area.
 - d. Maximum Protection Area per Sprinkler: 225 sq. ft.
 - e. Maximum Sprinkler Spacing: 15 ft.
 - f. Combined Hose-Stream Demand Requirement: 100 gpm.
 - g. Operation Duration: 30 minutes.
 2. Ordinary Hazard Group 1:
 - a. Definition: Occupancies where the quantity and combustibility of content do not exceed the amount of miscellaneous storage of Class 2,3,4, plastics, tires, and roll paper.
 - b. Examples:
 - 1) Building service areas.
 - 2) Electrical equipment rooms.
 - 3) General storage areas.
 - 4) Mechanical equipment rooms.
 - c. Minimum Design Area and Design Density: 0.15 gpm/sq. ft. over 1500-sq. ft. area.
 - d. Maximum Protection Area per Sprinkler: 130 sq. ft.
 - e. Maximum Sprinkler Spacing: 15 ft.
 - f. Combined Hose-Stream Demand Requirement: 250 gpm.
 - g. Operation Duration: 60 minutes.
 3. Ordinary Hazard Group 2:
 - a. Definition: Occupancies where the quantity and combustibility of content are moderate to high, stockpiles of contents with moderate rates of heat release do not exceed 12 ft, and stockpiles of contents with high rates of heat release do not exceed 8 ft.
 - b. Examples:
 - 1) Laboratories.
 - 2) Machine shops.
 - c. Minimum Design Area and Design Density: 0.20 gpm/sq. ft. over 1500-sq. ft. area.
 - d. Maximum Protection Area per Sprinkler: 130 sq. ft.
 - e. Maximum Sprinkler Spacing: 15 ft.
 - f. Combined Hose-Stream Demand Requirement: 250 gpm.
 - g. Operation Duration: 90 minutes.
 4. Design Area Adjustment: Adjust design area as required or allowed by NFPA 13 for quick-response sprinklers.
- H. Sprinkler Listing Design Criteria: All sprinklers shall be designed and installed in accordance with the product listing. Alternate design criteria recommended or required by a specific sprinkler listing may be utilized only when the sprinkler is approved for use on this project. Sprinkler listing design criteria approved for use on this project will take precedence over the criteria noted in Section this specification only to the extent indicated by the sprinkler listing.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- A. General:

1. Submittal shall contain all necessary information for the entire system. Partial submittals will not be accepted.
 2. Provide submittals, including shop drawings, samples, documentation and record drawings, to the Architect and Engineer to review on behalf of the Owner. This review is to verify conformance to project specifications and design concepts expressed in the contract documents. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details (i.e., dimensions) or for substantiating installation or performance of equipment or systems designed by the Contractor, all of which remain the Contractor's responsibility to the extent required by the contract documents. The review on behalf of the Owner shall not constitute approval of safety precautions of construction, means, method, techniques, sequences of procedures, approval of a specific assembly of which the item is a part.
- B. Product Data: For each type of product indicated, include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. When a product data shows more than one product, the specific proposed product shall be clearly indicated by arrows or other suitable means. Mark out all inapplicable items. Catalog data must have the item or model number to be provided clearly marked and all accessories indicated. Submit literature showing details of each item of equipment. Plainly indicate the intended use of each item shown. All manufacturers' data sheets shall clearly show all listings and approvals for each product submitted.
- D. Shop Drawings: Provide working drawings in accordance with applicable codes and standards, this specification, and Division 01.
1. Include plans drawn to scale, elevations, sections, details, and attachments to other work. Provide diagrams for power, signal, and control wiring.
 2. Indicate coordination with other fire-protection or non-fire-protection building systems including, but is not limited to, domestic water piping, compressed air piping, HVAC hydronic piping / ductwork, items penetrating ceiling assemblies, etc.
 3. Where permitted for use elsewhere in this specification and provided for this project, flexible sprinkler connections shall be clearly indicated on drawings including locations, manufacturer, length, outlet type, maximum bend radius, maximum number of bends, as well as attachment methods to all ceiling types.
 4. Grooved joint couplings and fittings shall be identified on drawings, including the manufacturer's listed model or series designation.
 5. Sprinklers identification or Model number shall be identified on drawings as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.
- E. Hydraulic Calculations: Prepared according to NFPA 13 and showing the pipe sizes proposed to produce adequate performance. Safety factor required in this specification shall be demonstrated in the hydraulic calculations. Where permitted for use elsewhere in this specification and provided for this project, flexible sprinkler connections shall be included in hydraulic calculations including manufacturer specific equivalent length for flexible connections and any right-angle/elbow fittings used for sprinkler attachment to flexible connections.
- F. Qualification Data: For qualified installer and designer.
- G. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- H. Fire-hydrant flow test report: Prepared according to NFPA 13 and NFPA 291. Include site plan indicating location of all flow and test hydrants.

- I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- J. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals. At a minimum, the following shall be included:
 - 1. 11-in. x 17-in. reduced copies of the 'as-built' record drawings required below (Final submittal only).
 - 2. Manufacturers' catalog data sheets and installation manuals for all installed components.
 - 3. Copy of NFPA 25.
 - 4. Copy of all test certificates and approvals.
 - 5. A list of recommended spare parts and summary of spare parts provided.
 - 6. A service directory, including a list of Contractor's contact names and telephone numbers for service on the system, including emergency service as required elsewhere in these Specifications.
- B. Contractor Record Drawings: Contractor shall provide and maintain on the site an up-to-date 'as-built' record set of approved shop drawing prints which shall be marked to show each and every change made to the sprinkler system from the original approved shop drawings. This requirement shall not be construed as authorization to deviate from or make changes to the shop drawings approved by Owner without written instruction from Owner in each case. These drawings shall be maintained in a current condition at all times and shall be made available for review immediately upon request during normal working hours throughout the installation. Upon completion of the 'as-built' record drawings and before final approval, one set of reproducible 'as-built' record drawings shall be delivered to Owner. Upon approval by Owner, three (3) sets of final record drawings shall be furnished to Owner. In addition, a record set of drawings shall be transmitted to Owner in the AutoCAD format with any applicable executable, un-archiving files.
- C. If Contractor's submittals, upon review by Owner, do not conform to the requirements of these specifications, Contractor shall be required to resubmit with modifications, within ten (10) working days of receipt of Owner's notification to Contractor. Contractor shall be responsible for Owner's expenses for subsequent review of rejected submittals that were necessitated by Contractor's failure to make the requested modifications. Such extra fees shall be deducted from payments by Owner to Contractor.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.9 QUALITY ASSURANCE

- A. All work shall conform to the requirements of the applicable editions and portions of the National Fire Protection Association (NFPA) Standards, locally adopted codes, and this specification.
 - 1. 2022 California Building Code with Local Amendments
 - 2. 2022 California Fire Code with Local Amendments
 - 3. NFPA 13 - 2022 edition, Standard for the Installation of Sprinkler Systems, California Edition
 - 4. NFPA 24 - 2019 edition, Standard for the Installation of Private Fire Service Mains and Their Appurtenances with California amendments
 - 5. NFPA 25 - 2013 edition, Standard for the Inspection, Testing and Maintenance of Water Based Fire Protection Systems, California Edition
 - 6. NFPA 70 - 2020 edition, National Electrical Code with Local Amendments

7. NFPA 72 - 2022 edition, National Fire Alarm and Signaling Code
- B. All work and materials shall conform to all Federal, State, and local codes and regulations governing this installation.
 - C. Installer Qualifications:
 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 2. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
 3. Contractor Requirements: System design shall be by personnel certified by NICET as Level III Water-Based Systems technician as a minimum. Contractor shall:
 - a. Hold all licenses and obtain all permits necessary to perform work of this type in the State of California. Copies of Contractor's licenses shall be provided with bid submittal.
 - b. Be regularly engaged, for the past 5 years in the design, installation, testing and servicing of automatic sprinkler systems for buildings of this type.
 - c. Have worked on one or more comparable new installation projects in the last five years.
 - d. Contractor's site supervisor will be at the job site at all times when work is actively in progress.
 - D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - E. Modifications to Specification: Contractor shall be responsible for the review and compliance with this Specification. All work shall be performed in accordance with the Specification and good engineering and installation practice. Modifications to the Specification will NOT be accepted without the expressed written approval of Owner and/or Architect/Engineer. It is the Contractor's responsibility to document the required approvals of any such modifications prior to the execution of work.
 - F. Code Conflicts: Should conflicts exist between the referenced NFPA Standards, Federal, State or local codes and this specification, it shall be Contractor's responsibility to bring the conflict to the attention of Owner for resolution. The contractor shall not attempt to resolve code conflicts with the local authority, independent of Owner. In general, in the event of a conflict, the most stringent of the requirements will apply.
 - G. Design Document Conflicts: The sprinkler Contract Drawings and this Specification define the Scope of work for the project. The Contract Drawings are intended to be schematic only, and the Contractor's responsibilities are defined herein. Where conflicts occur between this Specification and Contract Drawings, the contractors shall request clarification prior to bidding. In general, should a conflict occur, the Specification will overrule the Contract Drawings.
 - H. Permit Fees: Contractor shall be responsible for filing all documents, paying all fees and securing all permits, inspections and approvals necessary for completing the scope of the work in this section.
 - I. The Contractor shall be responsible for the cost to provide and install any additional devices required as part of the plan check and inspection process conducted by the AHJ.
 - J. Equipment: All devices, systems, equipment and materials furnished and installed shall be new and shall be submitted for approval by Owner. All sprinklers, pipe, fittings, hangers, valves, and other materials and equipment shall be UL Listed for their intended use. All shall be acceptable to the AHJ when such agencies have listings of acceptable equipment. The equipment and system components shall be installed in accordance with the applicable codes and standards, the manufacturers' recommendations, and within the limitations of the UL listings. All equipment and system components shall substantially be the standard product of a single manufacturer. Evidence of UL listings is required.

- K. Fittings: Fittings may be of the flanged, threaded, or grooved type. Welded outlets on cross-mains for riser nipples and/or branch lines and for sprinkler outlets on branch lines will be permitted. All shall be UL Listed for their intended use. The use of plain-end fittings to join steel pipe is not permitted.
1. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 2. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.10 WARRANTY AND EMERGENCY SERVICE

- A. Contractor shall warranty all materials and workmanship for a period of one (1) year beginning with the date of final acceptance of Contractor's completed installation by Owner. Contractor shall be responsible during the design, installation, testing and warranty periods for any damage caused by Contractor (or its subcontractors) or by defects in Contractor's (or its subcontractors') work, materials, or equipment.
- B. Emergency Service: During the installation and warranty period, Contractor shall provide emergency repair service for the sprinkler systems within twenty-four (24) hours of a request by Owner for such service. This service shall be provided on a 24-hour per day, seven days per week basis.

1.11 PROJECT CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions:
1. Notify Owner no fewer than two business days in advance of proposed interruption of sprinkler service.
 2. Do not proceed with interruption of sprinkler service without Owner's written permission.
 3. Provide compensating fire protection measure including, but not limited to, fire watch services when the existing fire sprinkler system is removed from service for more than four hours during a twenty-four-hour period. Compensating fire protection shall be approved by the AHJ.

1.12 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Schedule 40, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- C. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

- D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
- E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Installation-Ready fittings for Schedule 40 grooved end steel piping in sizes NPS 1- $\frac{1}{4}$ thru 2- $\frac{1}{2}$ (DN 32 thru DN 65). Fittings shall consist of a ductile iron housing with Installation-Ready ends, prelubricated Grade "E" EPDM Type 'A' gasket; and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi and FM approved for working pressure 365 psi.
 - 4. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting or factory manufactured from ASTM A53 steel pipe; with dimensions matching steel pipe.
 - 5. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber center-leg gasket with pipe stop to ensure proper groove engagement, alignment, pipe insertion depth, and bolts and nuts. Installation-Ready, for direct stab installation without field disassembly.
 - a. Rigid Type: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13, fully installed at visual pad-to-pad offset contact. Couplings that require exact gapping at specific torque ratings are not permitted.
 - b. Flexible Type: For use in locations where vibration attenuation and stress relief are required.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Grooved Joint Lubricants: Lubricate gasket in accordance with the manufacturer's published instructions with lubricant approved for the gasket elastomer and fluid media.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
 - 3. Unless specified elsewhere in this specification, valve NPS 2 and smaller shall have threaded ends, and NPS 2-1/2 and larger shall have grooved or flanged ends.

4. Subject to compliance with requirements, the following manufacturers are acceptable. Approved equal products may be used as substitute.
 - a. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO Inc.
 - d. Reliable Automatic Sprinkler Co., Inc.
 - e. Tyco Fire & Building Products LP.
 - f. Victaulic Company.
 - g. Viking Corporation.
 - h. Watts Water Technologies, Inc.

- B. Ball Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. NIBCO Inc.
 - c. Victaulic Company.
 - d. Viking Corporation.
 2. Standard: UL 1091 except with ball instead of disc.
 3. Valves NPS 1-1/2 and Smaller: Bronze or brass body with threaded or grooved ends.
 4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 5. Valves NPS 3: Ductile-iron body with grooved ends.

- C. Butterfly Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fivalco Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO Inc.
 - d. Reliable Automatic Sprinkler Co., Inc.
 - e. Tyco Fire & Building Products LP.
 - f. Viking Corporation.
 - g. Victaulic Company.
 2. Standard: UL 1091.
 3. Body Material: Bronze for NPS 2 and smaller. Cast of ductile iron for NPS 2-1/2 and larger.
 4. Seat: Pressure responsive elastomer.
 5. Stem: Stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.
 6. End Connections: Threaded, grooved, or flanged.
 7. Supervised butterfly valves shall be provided with an integral tamper switch. Valves to be supervised in the normally closed position shall be listed for normally closed operation. Integral tamper switches shall comply with the requirement of this specification.

- D. Check Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. Victaulic Company.
 - d. Viking Corporation.
 - e. Watts Water Technologies, Inc.
 2. Standard: UL 312.
 3. Type: Single swing check or spring-assisted type for vertical installation.
 4. Body Material: Cast ductile iron.
 5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
 6. Clapper Seat: Brass, bronze, or stainless steel.

7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged or grooved.

E. OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. Mueller Co.; Water Products Division.
 - c. NIBCO INC.
 - d. Tyco Fire & Building Products LP.
 - e. United Brass Works, Inc.
 - f. Victaulic Company
 - g. Watts Water Technologies, Inc.
2. Standard: UL 262.
3. Body Material: Bronze for NPS 2 and smaller. Cast of ductile iron for NPS 2-1/2 and larger.
4. Wedge and wedge seat: Cast or ductile iron, or bronze with elastomeric coating per valve listing.
5. Stem: Bronze or brass.
6. End Connections: Threaded, grooved, or flanged.

F. Indicating-Type Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO Inc.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig minimum.
4. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze or brass.
 - c. End Connections: Threaded or grooved.
5. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Seat: Pressure responsive elastomer.
 - c. Stem: Stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.
 - d. Body Material: Cast or ductile iron.
 - e. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Weatherproof actuator housing with factory installed integral electrical, 125-V ac, prewired, two-circuit, supervisory switches indicating device.

G. Indicator Posts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. American Valve, Inc.
 - c. NIBCO INC.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.
2. Standard: UL 789.
3. Type: Horizontal for wall mounting.
4. Body Material: Cast iron with extension rod and locking device.

5. Extension Barrel: Cast or ductile iron.
6. Cap: Cast or ductile iron.
7. Operation: Hand wheel.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
3. Unless specified elsewhere in this specification, valve NPS 2 and smaller shall have threaded ends, and NPS 2-1/2 and larger shall have grooved or flanged ends.
4. Subject to compliance with requirements, the following manufacturers are acceptable. Approved equal products may be used as substitute.
 - a. Anvil International, Inc.
 - b. Fire Protection Products, Inc.
 - c. Milwaukee Valve Company.
 - d. NIBCO Inc.
 - e. Potter Electric Signal Company.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - g. Tyco Fire & Building Products LP.
 - h. United Brass Works, Inc.
 - i. Victaulic Company.
 - j. Viking Corporation.
 - k. Watts Water Technologies, Inc.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire Protection Products, Inc.
 - b. United Brass Works, Inc.
2. Description:
 - a. Pressure Rating: 175 psig.
 - b. Body Material: Brass or bronze.
 - c. Ends: Threaded.
 - d. Stem: Bronze.
 - e. Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze, or aluminum.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Potter Electric Signal Company.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Description:
 - a. Pressure Rating: 175 psig.
 - b. Body Design: Two piece.
 - c. Body Material: Forged brass or bronze.
 - d. Port size: Full or standard.
 - e. Seats: PTFE.
 - f. Stem: Bronze or stainless steel.
 - g. Ball: Chrome-plated brass.
 - h. Actuator: Hand-lever.
 - i. Packing: Asbestos free.

- j. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
- k. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

D. Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire Protection Products, Inc.
 - b. United Brass Works, Inc.
2. Description:
 - a. Pressure Rating: 175 psig.
 - b. Body Material: Bronze with integral seat and screw-in bonnet.
 - c. Ends: Threaded.
 - d. Stem: Bronze.
 - e. Disc Holder and Nut: Bronze.
 - f. Disc Seat: Nitrile.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

2.6 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Valve internal components shall be replaceable without removal of valve from installed position.
5. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber, and fill-line attachment with strainer.
6. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
7. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

D. Preassembled Manifold and Floor/Zone Control Valve Assemblies:

1. UL listed and FM approved, ductile-iron body with flanged end connections, 175-psig minimum pressure rating. Assembly shall include
 - a. Universal Manifold Check Valve: Ductile iron construction, incorporating a control valve, check valve, flow switch, test and drain assembly, adjustable relief valve, and system gauges in one compact body/footprint.
 - b. Universal Manifold: Ductile iron construction, incorporating a control valve, flow switch, test and drain assembly, adjustable relief valve, and system gauges in one compact body/footprint.
 - c. Test and Drain Assembly: Contain an adjustable relief valve, with a range of 175 to 310 psi.
2. Maximum Pressure: 300 psig.
3. Minimum Pressure: 175 psig.

2.7 FIRE DEPARTMENT CONNECTIONS

A. Free-Standing Fire Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Elkhart Brass Mfg. Company, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Potter Roemer.
2. Standard: UL 405.
3. Type: Exposed, freestanding STORZ connector.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, floor type.
9. Outlet: Bottom, with pipe threads.
10. Number of Inlets: Two.
11. Sleeve: Brass.
12. Sleeve Height: 18 inches.
13. Escutcheon Plate Marking: Similar to "AUTO SPKR."
14. Finish, Including Sleeve: Polished chrome plated .
15. Outlet Size: NPS 4.

- B. At the low point near each fire department connection, install a 90-degree elbow with drain connection to allow for localized system drainage to prevent freezing.

2.8 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Ductile-iron housing with branch outlets.

7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 8. Branch Outlets: Grooved, plain-end pipe, or threaded.
 9. Mechanical Tees utilizing U-bolt, snap-on, or strapless style assemblies are not permitted.
 10. Where mechanical tee and cross type fittings are utilized, "coupon" cut-out section of piping shall be permanently attached to the fitting to provide visual confirmation that outlets were properly cut.
- B. Test and Drain Valve Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 3. Pressure Rating: 175 psig minimum.
 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 5. Size: Same as connected piping.
 6. Inlet and Outlet: Threaded or grooved.
- C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Potter Electric Signal Company.
 2. Standard: UL 199.
 3. Pressure Rating: 175 psig.
 4. Body Material: Brass.
 5. Size: Same as connected piping.
 6. Inlet: Threaded.
 7. Drain Outlet: Threaded and capped.
 8. Branch Outlet: Threaded, for sprinkler.
- D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Tyco Fire & Building Products LP.
 - b. Victaulic Company.
 - c. Viking Corporation.
 2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 3. Pressure Rating: 175 psig minimum.
 4. Body Material: Cast- or ductile-iron housing with sight glass.
 5. Size: Same as connected piping.
 6. Inlet and Outlet: Threaded or grooved.
- E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CECA, LLC.
 - b. Corcoran Piping System Co.
 - c. Merit Manufacturing; a division of Anvil International, Inc.
 2. Standard: UL 1474.
 3. Pressure Rating: 250 psig minimum.
 4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 5. Size: Same as connected piping.

6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. FlexHead Industries, Inc.
 - b. Victaulic Company.
2. Standard: UL 2443.
3. Type: Braided type 304 stainless steel flexible hose with nominal 1-inch internal diameter for connection to sprinkler, and with bracket for connection to ceiling grid. The drop shall have a minimum bend radius of 2-inch. The number of bends shall not exceed that specified by listing or manufacturer's instruction, whichever is more restrictive. Hydraulic calculations shall utilize values for the maximum number of bends and minimum bend radius permitted for the hose assembly.
4. The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
5. The drop shall include a UL approved Series AH1 with 3" bend radius; AH2 or AH2-CC braided hose.
6. Union joints shall be provided for ease of installation.
7. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 or AB2 bracket. The bracket shall allow installation before the ceiling tile is in place.
8. Pressure Rating: 175 psig minimum.
9. Size: Same as connected piping, for sprinkler.

2.9 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Victaulic Company.
4. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Sprinklers shall be glass bulb type, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.
 - a. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss cast in the sprinkler body.
3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. Characteristics: Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes and Special Coating: Factory-applied per Sprinkler Schedule.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers. Refer to Sprinkler Finish Schedule.

F. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

- G. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.10 ALARM AND SUPERVISORY DEVICES

- A. Alarm-device types shall match piping and equipment connections.

- B. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Notifier; a Honeywell company.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 10-inch diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

- C. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
 - c. Viking Corporation.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

- D. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Potter Electric Signal Company.
 - c. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position or other than the full-closed position for normally-closed valves.

- E. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.11 PRESSURE GAUGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. Brecco Corporation.
 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gauge Range: 0 to 250 psig minimum.
- E. Water System Piping Gauge: Include "WATER" label on dial face.

2.12 IDENTIFICATION SIGNS AND LABELS

- A. General: Identification signs shall be rigid, metal plaques with embossed enamel background and lettering. Signs shall be secured by chain or durable wire to each sprinkler zone control valve, main and auxiliary drain, and inspector's test valve, etc. System hydraulic calculation placards affixed using adhesives, and/or using permanent marker for information, are NOT acceptable.
- B. Hydraulic Calculation Signs:
 1. Contractor shall furnish and install hydraulic calculation signs for each new sprinkler and standpipe zone. Hydraulic calculation signs shall be affixed to the corresponding system riser downstream of the system control valve and main drain at the riser.
 2. Hydraulic calculation signs shall include all information indicated in NFPA 13 and appendices. Valve identification signs shall identify the function of the valve and the area served.
- C. Equipment Labels
 1. Material and Thickness: stainless steel, 0.025 inch aluminum, 0.032 inch or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
 2. Letter Color: Black.
 3. Background Color: White.
 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Fasteners: Stainless-steel rivets.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- D. Pipe Labels
 1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.

2. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
3. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
4. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - a. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - b. Lettering Size: Size letters according to ASME A13.1 for piping.
5. Pipe-Label Colors:
 - a. Background Color: Safety Red.
 - b. Letter Color: White.

E. Stencils

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Stencil Material: Fiberboard or metal.
3. Stencil Paint: Safety Red, exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: White, exterior, alkyd enamel. Paint may be in pressurized spray-can form.

F. Valve Tags

1. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
2. Tag Material: stainless steel, 0.025 inch aluminum, 0.032 inch anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
3. Fasteners: Brass wire-link chain or beaded chain.
4. Valve-Tag Color: Safety Red.
5. Letter Color: White.
6. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - a. Valve-tag schedule shall be included in operation and maintenance data.

2.13 ESCUTCHEONS

- A. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- B. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.14 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.15 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.16 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.17 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.18 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.19 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for sprinkler piping and connections to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections/stations, sprinklers, and piping are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Perform fire-hydrant flow test in accordance with NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.
- C. Coordinate with other trades.
- D. Obtain owner's approval for all openings or penetrations.
- E. Obtain final approval of design documents prior to installation.

3.3 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.4 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves.
 - 2. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system Sleeve-seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
 - 4. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

3.7 ESCUTCHEON INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - f. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.

2. Escutcheons for Existing Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
 - c. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 1. New Piping: One-piece, floor-plate type.
 2. Existing Piping: Split-casting, floor-plate type.
- E. Replace broken and damaged escutcheons and floor plates using new materials.

3.8 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- B. Install shutoff valve, pressure gauge, drain, and other accessories indicated at connection to water-service piping.
- C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water service.

3.9 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."
- B. Install shutoff valve, pressure gauge, drain, and other accessories indicated at connection to water-distribution piping.

3.10 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install automatic (ball drip) drain valve at each check valve for fire department connection, to drain piping between fire department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- J. Install alarm devices (e.g., flow switches) in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- L. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each riser. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.
- M. Fill wet-pipe sprinkler system piping with water.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors.
- O. Install sleeve seals for piping penetrations of concrete walls and slabs.
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.11 FLEXIBLE SPRINKLER CONNECTION INSTALLATION

- A. Installation shall be in accordance with manufacturers recommendations.
- B. Connection to branch shall be made a minimum 45 degrees from horizontal. Where connections off a side or bottom of branchline are required due to coordination, locations shall be clearly indicated on shop drawings and approved by Engineer.

3.12 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer's latest published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.
- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer's latest published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

3.13 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13, manufacturer's instructions, and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the pipe center.
- F. Install valves in position to allow full stem movement.
- G. Install valve tags. Comply with requirements in this specification for Identification Signs and Labels for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.
- H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
- I. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
- J. Supervisory Switches: Install supervisory switches for sprinkler control valves to monitor closure of the valve and for high and low system supervisory nitrogen pressure to monitor abnormal system pressures.
- K. Pressure Alarm Switches: Install alarm pressure switches in easily accessible locations.

3.14 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.
- C. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb. The sprinkler bulb protector shall be removable by hand, without tools or devices that may damage the bulb.

3.15 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install yard-type, fire department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."
 1. Install protective pipe bollards around each fire department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."
- B. Install automatic (ball drip) drain valve at each check valve for fire department connection.

3.16 IDENTIFICATION SIGNS AND LABELS

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13. Identify system components, wiring, cabling, and terminals. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed. Coordinate installation of identifying devices with locations of access panels and doors. Install identifying devices before installing acoustical ceilings and similar concealment.
- B. Equipment Label Installation: Install or permanently fasten labels on each major item of mechanical equipment. Locate equipment labels where accessible and visible.
- C. Pipe Label Installation: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit a view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Valve Identification Sign Installation: Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule. Tag valves according to size, shape, and with captions similar to those indicated below:

1. Wet-Pipe Sprinkler System: 2 inches, square.

3.17 FIELD QUALITY CONTROL

- A. Perform pretests and inspections prior to Final Inspection and Tests.
- B. Pretests and Inspections shall include the following at a minimum:
 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 2. Pretest and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Verify that equipment hose threads are same as local fire department equipment.
- C. Correct all deficiencies identified during pretest and inspection prior to scheduling Final Inspection and Test.

3.18 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.19 FINAL INSPECTION AND TEST

- A. Contractor shall make arrangements with Owner for Owner's final inspection and the local authorities.
- B. All tests and inspections required by the referenced Codes and Standards, AHJ, and Owner shall be conducted by Contractor under this scope of work.
 1. When AHJ are required to witness tests, Contractor shall be responsible for making all necessary arrangements with the code authorities and coordinating the testing with Owner.
- C. Contractor shall be responsible for completing all test documents with necessary approval stamps and signatures of the AHJ. Contractor shall submit one copy of each of these documents to Owner for their records.
- D. Tests and Inspections:
 1. An air pressure test shall be conducted prior to filling the system with water. Establish 40 psig air pressure and measure drop, which shall not exceed 1½psig in 24 hours. Air pressure during this test shall be tracked via a graph over the 24-hour period by a pressure monitoring device or pressure monitoring gauge. Repair leaks and retest until no leaks exist.
 2. Hydrostatic Test: Hydrostatic tests shall be conducted at the greater of 200 psig or 50 psig above the normal system pressure, whichever is greater, for a two-hour period with no leakage or reduction in gauge pressure. Charge systems and test for leaks. Repair leaks and retest until no leaks exist. Hydrostatic test pressures shall not be maintained on the system overnight. Flush piping with potable water in accordance with NFPA 13.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 4. Flush, test, and inspect standpipe systems according to NFPA 13, "System Acceptance" Chapter.
 5. Energize circuits to electrical equipment and devices.
 6. Coordinate with fire-alarm tests. Operate as required.
- E. Prepare test and inspection reports.

3.20 FINAL APPROVAL

- A. Final approval and acceptance of the work will be given by Owner when:
 - 1. The completed sprinkler system has been inspected, tested and approved by Owner and AHJ.
 - 2. Required submittals, system operation and maintenance manuals, record drawings, spare parts, special tools and training have been provided to, reviewed, and accepted by Owner.
 - 3. Written certification is submitted that states all equipment has been inspected and tested by a manufacturer's certified representative.
 - 4. Written certification is submitted that states all equipment is installed in accordance with the manufacturer's recommendations and UL and/or FM approvals.
- B. Owner's Representative may visit the job site to observe the work and witness the final acceptance tests when advised by Contractor that the work is complete and ready for test. If the work has not been completed, or the test is unsatisfactory, Contractor shall be responsible for Owner's added expenses for re-inspection and witnessing the retesting of the work. Such extra fees shall be deducted from payments by Owner to Contractor.
- C. Additional Tests: Any additional tests, required by the referenced codes, standards, or criteria, or by Owner, shall be performed.

3.21 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.
- B. Contractor shall conduct one four-hour training session(s) at the project site to familiarize the building personnel with the features, operation and maintenance of the sprinklers and standpipe. Training sessions shall be scheduled by Owner at a time mutually agreeable to Contractor and Owner.

3.22 PIPING SCHEDULE

- A. Exposed piping in public areas shall be painted to match surrounding finishes. Finish colors shall be coordinated with and approved by the architect.
- B. Piping between Fire Department Connections and Check Valves: Galvanized, Schedule 40 steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.
- C. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 40, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
 - 1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 40, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- F. Standard-pressure, wet-pipe sprinkler system, NPS 4-1/2 and larger, shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.23 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: .
 - a. Public areas: Upright sprinkler finish shall match surrounding finishes.
 - b. Back of house areas: Upright sprinkler finish shall be brass.
 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
 3. Wall Mounting: Sidewall sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - a. Specialty Ceiling Finishes: Provide manufacturers standard or custom color cover plate as selected by the Architect.
 2. Flush Sprinklers: Bright chrome with painted white escutcheon.
 3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 4. Upright Pendent and Sidewall Sprinklers: White in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Provide a maintenance free, circumferential conductive micro fiber grounding ring installed on the AC motor to discharge shaft currents to ground. Grounding ring shall be AEGIS SGR (Shaft Grounding Ring).
- D. Motors protected by the AEGIS SGR shall be warranted for the term of the manufacturer's motor warranty from induced bearing current damage.
- E. Motors up to 100 HP shall be provided with one shaft grounding ring installed on either the drive end or non-drive end. Motors over 100 HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the shaft grounding ring manufacturer's recommendations.
- F. All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high-frequency ground strap made of flat braided tinned copper with terminations to accommodate motor foot and system ground connection .

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F .
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.

- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rubber packless expansion joints.
 - 2. Grooved-joint expansion joints.
 - 3. Alignment guides and anchors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

- A. Rubber Union Connector Expansion Joints :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Mason Industries, Inc.
 - 2. Material: Twin reinforced-rubber spheres with external restraining cables.
 - 3. Minimum Pressure Rating: 150 psig at 170 deg F unless otherwise indicated.
 - 4. End Connections for NPS 2 and Smaller: Threaded.
- B. Flexible-Hose Packless Expansion Joints :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Mason Industries, Inc.
 - d. Metraflex, Inc.
 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
 5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
 6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
 7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- C. Metal-Bellows Packless Expansion Joints :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Hyspan Precision Products, Inc.
 - c. Metraflex, Inc.
 2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 3. Type: Circular, corrugated bellows with external tie rods.
 4. Minimum Pressure Rating: 150 psig Insert value, unless otherwise indicated.
 5. Configuration: Single joint with base double joint with base class(es), unless otherwise indicated.
 6. Expansion Joints for Copper Tubing: multi- ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: threaded.
 - c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.
 7. Expansion Joints for Steel Piping: multi- ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.

- b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

2.3 GROOVED-JOINT EXPANSION JOINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anvil International, Inc.
 - 2. Shurjoint Piping Products.
 - 3. Victaulic Company.
- B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- E. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water, and bolts and nuts.

2.4 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Hyspan Precision Products, Inc.
 - c. Mason Industries, Inc.
 - d. Metraflex, Inc.
 - 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.
- B. Anchor Materials:
 - 1. Steel Shapes and Plates: ASTM A 36/A 36M.
 - 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
 - 3. Washers: ASTM F 844, steel, plain, flat washers.
 - 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
 - 5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.

- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-PSJ-703.
- D. Install grooved-joint expansion joints to grooved-end steel piping.

3.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Grout.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Plastic.

3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
- D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6 Cast-iron wall sleeves
 - 2. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system .
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system .
 - 3. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves .

END OF SECTION

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. BrassCraft Manufacturing Co.; a Masco company.
 - 2. Dearborn Brass.
 - 3. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

- A. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- D. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

2.3 FLOOR PLATES

- A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece steel with polished, chrome-plated finish or One-piece stainless steel with polished stainless-steel finish.

- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish or One-piece stainless steel with polished stainless-steel finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish or One-piece stainless steel with polished stainless-steel finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish or One-piece steel with polished, chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping and Relocated Existing Piping: One-piece, floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Test-plug kits.

- B. Related Requirements:
 - 1. Section 211100 "Facility Fire-Suppression Water-Service Piping" for fire-protection water-service meters outside the building.
 - 2. Section 211200 "Fire-Suppression Standpipes" for fire protection pressure gages.
 - 3. Section 211313 "Wet-Pipe Sprinkler Systems"
 - 4. Section 211316 "Dry-Pipe Sprinkler Systems" for fire protection pressure gages.
 - 5. Section 211339 "Foam-Water Systems" for fire protection pressure gages.
 - 6. Section 221113 "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
 - 7. Section 221116 "Domestic Water Piping" for water meters inside the building.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Terrice, H. O. Co.
 - 3. Standard: ASME B40.200.
 - 4. Case: Cast aluminum ; 6-inch nominal size.
 - 5. Case Form: Straight unless otherwise indicated.
 - 6. Tube: Glass with magnifying lens and blue or red organic liquid.

7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
8. Window: Glass or plastic.
9. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
10. Connector: 3/4 inch, with ASME B1.1 screw threads.
11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR .
4. Material for Use with Steel Piping: CRES .
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin .

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Flo Fab Inc.
 - c. Terrice, H. O. Co.
 - d. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - e. Weiss Instruments, Inc.
 - f. WIKA Instrument Corporation - USA.
2. Standard: ASME B40.100.
3. Case: Sealed type(s); cast aluminum or drawn steel ; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic .
10. Ring: Brass.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston -type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. National Meter, Inc.
 - 2. Peterson Equipment Co., Inc.
 - 3. Sisco Manufacturing Company, Inc.
 - 4. Terrice, H. O. Co.
 - 5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 6. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F .
- F. Core Inserts: EPDM self-sealing rubber.

2.6 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. National Meter, Inc.
 - 2. Peterson Equipment Co., Inc.
 - 3. Sisco Manufacturing Company, Inc.
 - 4. Terrice, H. O. Co.
 - 5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 6. Weiss Instruments, Inc.
- B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F .
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F .
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig .
- F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install test plugs in piping tees.
- K. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
 - 2. Inlets and outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
 - 4. Inlet and outlet of each remote domestic water chiller.
- L. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be the following:
 - 1. Compact -style, liquid-in-glass type.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be the following:
 - 1. Compact -style, liquid-in-glass type.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

- B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:
 - 1. Sealed , remote-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- B. Pressure gages at suction and discharge of each domestic water pump shall be the following:
 - 1. Liquid-filled , direct -mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Water Piping: 0 to 160 psi.

END OF SECTION

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. RPTFE: Reinforced polytetrafluoroethylene.
- C. WOG: Water, oil, gas.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, and soldered ends.
 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Standards:
1. Domestic water valves intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.5 for flanges on steel valves.
 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 5. ASME B16.18 for cast copper solder-joint connections.
 6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
 7. ASME B16.34 for flanged and threaded end connections
 8. ASME B31.9 for building services piping valves.
- C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Type:
1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
 2. Hand Lever: For quarter-turn valves smaller than NPS 4.
- G. Valves in Insulated Piping:
1. Provide 2-inch extended neck stems.
 2. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 3. Memory stops that are fully adjustable after insulation is applied.

2.3 BRONZE BALL VALVES

- A. Bronze Ball Valves, Two Piece with Full Port and Stainless Steel Trim, Threaded or Soldered Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. WATTS.
 2. Standard: MSS SP-110; MSS SP-145.
 3. CWP Rating: 600 psig.
 4. Body Design: Two piece.
 5. Body Material: Bronze.
 6. Ends: Threaded or soldered.
 7. Seats: PTFE.
 8. Stem: Stainless steel.
 9. Ball: Stainless steel, vented.
 10. Port: Full.
- B. Bronze Ball Valves, Three Piece with Full Port and Stainless Steel Trim, Threaded Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. DynaQuip Controls.
 - c. NIBCO INC.

2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

C. Bronze Ball Valves, Two Piece, Safety-Exhaust, Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. DynaQuip Controls.
 - c. Lance Valves.
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Bronze, ASTM B584, Alloy C844.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.
10. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

- B. Provide support to piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access.
- D. For valves in horizontal piping, install valves with stem at or above center of pipe.
- E. Install valves in position to allow full valve actuation movement.
- F. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE - 150 PSIG OR LESS

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze ball valves, two piece with full port, and stainless steel trim.
 - 3. Bronze ball valve, three piece with full port, and stainless steel trim.

3.6 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze ball valves, two piece with full port, and stainless steel trim. Provide with threaded solder-joint ends.

END OF SECTION 220523.12

SECTION 220523.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Iron, single-flange butterfly valves.
 - 2. Chainwheels.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set butterfly valves closed or slightly open.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.1 for flanges on iron valves.
 - 2. ASME B16.5 for flanges on steel valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B31.9 for building service piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

- D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Gear Actuator: For valves NPS 8 and larger.
 - 2. Handlever: For valves NPS 6 and smaller.
 - 3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.
- H. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Red White Valve Corp.
 - e. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
 - h. Kennedy Valve Company; a division of McWane, Inc.
 - i. Kennedy Valve Company; a division of McWane, Inc.
 - j. NIBCO INC.

2.3 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries.
 - 3. Trumbull Industries.
 - 4. .
- B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.
 - 1. Sprocket Rim with Chain Guides: Aluminum , of type and size required for valve.
 - 2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2-1/2 and Larger:
 - 1. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze disc.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2-1/2 and Larger:
 - 1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.

END OF SECTION 220523.13

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bronze lift check valves.
 - 2. Bronze swing check valves.
 - 3. Bronze swing check valves, press ends.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder joint.
 - 5. ASME B31.9 for building services piping valves.

- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 Annex G and NSF 372.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE LIFT CHECK VALVES

- A. Bronze Lift Check Valves with Bronze Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane; Crane Energy Flow Solutions.
 - b. Jenkins Valves; Crane Energy Flow Solutions.
 - c. Stockham; Crane Energy Flow Solutions.
 - d. .
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
 - g. NIBCO INC.
 - h. Red White Valve Corp.

2.3 BRONZE SWING CHECK VALVES

- A. Bronze Swing Check Valves with Bronze Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. Crane; Crane Energy Flow Solutions.
 - d. Hammond Valve.
 - e. Jenkins Valves; Crane Energy Flow Solutions.
 - f. KITZ Corporation.
 - g. Macomb Groups (The).
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Red White Valve Corp.
 - l. Stockham; Crane Energy Flow Solutions.
 - m. WATTS.
 - n. Insert manufacturer's name.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.

- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: Bronze.

B. Bronze Swing Check Valves, Press Ends:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Elkhart Products Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. .
- 2. Description:
 - a. Standard: MSS SP-80 and MSS SP-139.
 - b. CWP Rating: Minimum 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 584, bronze.
 - e. Ends: Press.
 - f. Press Ends Connection Rating: Minimum 200 psig
 - g. Disc: Brass or bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Check Valves: Install check valves for proper direction of flow.
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Plate-Type Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

- a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
- b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat check valves.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Vertical, Upflow Applications Only: Bronze lift check valves with bronze disc, Class 125, with soldered or threaded end connections.
2. Horizontal and Vertical Applications: Bronze swing check valves with bronze disc, Class 125, with soldered or threaded end connections.

3.6 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller:

1. Bronze swing check valves with bronze disc, Class 125, with soldered or threaded end connections.
2. Bronze swing check valves with press-end connections.

END OF SECTION 220523.14

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment stands.
 - 8. Equipment supports.

- B. Related Requirements
 - 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
 - 3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to [ASCE/SEI 7].
 - 1. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 2. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of [carbon steel] [stainless steel] .
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel .
- C. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of [copper-coated steel] [stainless steel] .

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEM

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. Unistrut Corporation; Tyco International, Ltd.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with inturred lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
 - 7. Metallic Coating: Electroplated zinc.
 - 8. Framing systems in paragraph below should be equal to or able to exceed MFMA-4 requirements

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
 - a. Anvil International; a subsidiary of Mueller Water Products Inc.
 - b. Empire Industries, Inc.
 - c. ERICO International Corporation.
 - d. Haydon Corporation; H-Strut Division.
 - e. NIBCO INC.
 - f. PHD Manufacturing, Inc.
 - g. PHS Industries, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of [carbon steel] [stainless steel] .
7. Coating: None.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. ERICO International Corporation.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. Piping Technology & Products, Inc.
6. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece [plastic] [stainless-steel] base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- C. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- D. Install lateral bracing with pipe hangers and supports to prevent swaying.
- E. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- B. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use copper-plated pipe hangers and attachments for copper piping and tubing.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb (680 kg).
 - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

- Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Elastomeric isolation pads.
 2. Elastomeric isolation mounts.
 3. Open-spring isolators.
 4. Pipe-riser resilient supports.
 5. Elastomeric hangers.
 6. Spring hangers.
 7. Snubbers.
 8. Restraint channel bracings.
 9. Restraint cables.
 10. Seismic-restraint accessories.
 11. Mechanical anchor bolts.
- B. Related Requirements:
1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
 2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.2 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

- B. Welding certificates.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads: .
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ace Mountings Co., Inc.
 - b. Isolation Technology, Inc.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Pad Material: Oil and water resistant with elastomeric properties.
 - 5. Surface Pattern: Smooth, Ribbed, or Waffle pattern.
 - 6. Infused nonwoven cotton or synthetic fibers.
 - 7. Load-bearing metal plates adhered to pads.
 - 8. Sandwich-Core Material: Resilient.
 - a. Surface Pattern: [Smooth,] [Ribbed, or] [Waffle] pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts: .
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 - 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 OPEN-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. California Dynamics Corporation.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.4 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene .
1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psigon isolation material providing equal isolation in all directions.

2.5 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. California Dynamics Corporation.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.6 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .
1. Manufacturers: Subject to compliance with requirements,provide products by the following:
 - a. California Dynamics Corporation.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.7 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Vibration Mountings & Controls, Inc.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.8 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Cooper B-Line, Inc.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. Unistrut.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.9 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Kinetics Noise Control, Inc.
 2. Loos & Co., Inc.
 3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.10 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Cooper B-Line, Inc.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. TOLCO.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.11 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

- D. Equipment Restraints:
1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Piping Restraints:
1. Comply with requirements in MSS SP-127.
 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 3. Brace a change of direction longer than 12 feet.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- K. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 221116 "Domestic Water Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Valve tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Brady Corporation.
 - b. Craftmark Identification Systems.
 - c. Marking Services Inc.
 - 2. Material and Thickness: stainless steel, 0.025-inch and having predrilled or stamped holes for attachment hardware.
 - 3. Letter Color: Black.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 6. Fasteners: Stainless-steel rivets or self-tapping screws.

2.2 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Brady Corporation.
 - 2. Marking Services Inc.
 - 3. Seton Identification Products.

- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Letter Sizes: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Brady Corporation.
 - 2. Marking Services Inc.
 - 3. Seton Identification Products.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: stainless steel, 0.025-inch , 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass S-hook.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.

- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
 - 1. Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.
 - 2. Vacuum Piping
 - a. Background: Yellow.
 - b. Letter Colors: Black.
 - 3. Domestic and Lab Water Piping
 - a. Background: Safety green.
 - b. Letter Color: White.
 - 4. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Safety black.
 - b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches (38 mm), round.
 - b. Hot Water: 1-1/2 inches, round.
 - c. Compressed Air: 1-1/2 inches, round.
 - d. Vacuum: 1-1/2 inches, round.
 - 2. Valve-Tag Colors:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - c. Compressed Air: Natural.
 - d. Vacuum: Natural.
 - 3. Letter Colors:
 - a. Cold Water: White.
 - b. Hot Water: White.
 - c. Compressed Air: White.
 - d. Vacuum: White.

END OF SECTION

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic and lab hot-water piping.
 - 2. Domestic and lab recirculating hot-water piping.
 - 3. Supplies and drains for accessible lavatories and sinks.
- B. Related Requirements:
 - 1. Section 220716 "Plumbing Equipment Insulation."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Mineral-Fiber, Preformed Pipe Insulation:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000-Degree Pipe Insulation.
 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Super-Stik.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

2.4 MASTICS

- A. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.

- b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 4. Color: White or gray.
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. Or equal.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - b. Or equal.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches] [4 inches] o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic and Lab Hot and Recirculated Hot Water:
 1. NSP 3/4and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 2. INPS 1 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1.5 inch thick.
- B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- C. Floor Drains, Traps, and Sanitary Drain Piping Receiving Condensate and Equipment Drain Water below 60 Deg F:
 1. All Pipe Sizes: Insulation shall be[one of] the following:

- a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
 - 2. .
- D. Piping, Exposed:
 - 1. None.
 - 2. PVC: 20 mils thick.
 - 3. .

END OF SECTION

SECTION 220800 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes Cx process requirements for the following plumbing systems, assemblies, and equipment:
 - 1. Domestic hot- and cold-water piping.
 - 2. Sanitary waste and vent piping.
 - 3. Storm drainage piping.
 - 4. Plumbing pumps.
 - 5. Plumbing equipment.
 - 6. Compressed-air piping and equipment for laboratory facilities.
 - 7. Vacuum piping and equipment for laboratory facilities.
 - 8. Chemical waste systems for laboratory facilities.
 - 9. Processed water systems for laboratory facilities.

- B. Related Requirements:
 - 1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
 - 2. For construction checklists, comply with requirements in various Division 22 Sections specifying plumbing systems, system components, equipment, and products.

1.2 DEFINITIONS

- A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
- B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
- C. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For plumbing testing technician.
- B. Construction Checklists: Draft construction checklists will be created by CxA for Contractor review.
- C. Construction Checklists: Material, installation, and performance test checklists for systems, assemblies, subsystems, equipment, and components to be part of the Cx process and according to requirements in Section 019113 "General Commissioning Requirements."
 - 1. Domestic water piping, including the following:
 - a. Domestic cold- and hot-water piping, fittings, and specialties inside the building.
 - b. Pumps, motors, accessories, and controls.
 - c. Sleeves and sleeve seals.
 - d. Indoor water-storage tanks.
 - e. Meters and gages.
 - f. General-duty and specialty valves.
 - g. Hangers and supports.
 - h. Vibration isolation and seismic restraints.
 - 2. Sanitary waste and vent piping, including the following:
 - a. Gravity and forced-main sewerage piping, fittings, and specialties.

- b. Sanitary waste interceptors.
 - c. Pumps, motors, accessories, and controls.
 - d. Drains.
 - e. Sleeves and sleeve seals.
 - f. General-duty and specialty valves.
 - g. Hangers and supports.
 - h. Vibration isolation and seismic restraints.
3. Storm-water piping, including the following:
 - a. Drainage piping, fittings, and specialties.
 - b. Pumps, motors, accessories, and controls.
 - c. Drains and collection basins.
 - d. Rainwater collection and storage equipment.
 - e. Sleeves and sleeve seals.
 - f. General-duty and specialty valves.
 - g. Hangers and supports.
 - h. Vibration isolation and seismic restraints.
 4. Plumbing fixtures, including the following:
 - a. Water closets, supports and connections, supplies, and flush valves.
 - b. Urinals, supports and connections, supplies, and flush valves.
 - c. Lavatories, supports, supplies, drain connections, and faucets.
 - d. Sinks, supports, supplies, drain connections, and faucets.
 - e. Emergency plumbing fixtures, supplies, drain connections, and controls.
 - f. Drinking fountains, supplies, and drainage connections.
 5. Compressed-air piping for laboratory facilities, including the following:
 - a. Piping, fittings, and specialties inside the building.
 - b. Compressors, motors, accessories, and controls.
 - c. Compressed-air outlets and connections.
 - d. Sleeves and sleeve seals.
 - e. Meters and gages.
 - f. General-duty and specialty valves.
 - g. Hangers and supports.
 - h. Vibration isolation and seismic restraints.
 6. Vacuum piping for laboratory facilities, including the following:
 - a. Piping, fittings, and specialties inside the building.
 - b. Vacuum pumps, motors, accessories, and controls.
 - c. Vacuum terminal units and connections.
 - d. Sleeves and sleeve seals.
 - e. Meters and gages.
 - f. General-duty and specialty valves.
 - g. Hangers and supports.
 - h. Vibration isolation and seismic restraints.
 7. Processed water piping for laboratory and healthcare facilities, including the following:
 - a. Water piping, fittings, and specialties inside the building.
 - b. Water purification equipment, accessories, and controls.
 - c. Pumps, motors, accessories, and controls.
 - d. Sleeves and sleeve seals.
 - e. Meters and gages.
 - f. General-duty and specialty valves.
 - g. Hangers and supports.
 - h. Vibration isolation[and seismic restraints].
- D. Test equipment and instrumentation list, identifying the following:
1. Equipment/instrument identification number.
 2. Planned Cx application or use.

3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:
 - a. Instrument or tool identification number.
 - b. Equipment schedule designation of equipment for which the instrument or tool is required.
 - c. Manufacturer, make, model, and serial number.
 - d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.4 QUALITY ASSURANCE

- A. Plumbing Testing Technician Qualifications: Technicians to perform plumbing construction checklist verification tests, construction checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:
 1. Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.
 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
- B. Testing Equipment and Instrumentation Quality and Calibration:
 1. Capable of testing and measuring performance within the specified acceptance criteria.
 2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
 3. Be maintained in good repair and operating condition throughout duration of use on Project.
 4. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- C. Proprietary Test Instrumentation and Tools:
 1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
 - a. Be calibrated by manufacturer with current calibration tags permanently affixed.
 - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
 - c. Plumbing system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

- A. Prepare detailed construction checklists for plumbing systems, assemblies, subsystems, equipment, and components.
 1. Domestic hot- and cold-water piping.
 2. Sanitary waste and vent piping.
 3. Storm drainage piping.
 4. Plumbing pumps.
 5. Plumbing equipment, including the following:

- a. Water softeners.
 - b. Water storage tanks.
 - c. Water filtration equipment.
 - d. Domestic water heating equipment.
 - e. Plumbing fixtures.
6. Compressed-air piping and equipment for laboratory facilities.
 7. Vacuum piping and equipment for laboratory facilities.
 8. Chemical waste systems for laboratory facilities.
 9. Processed water systems for laboratory facilities.

3.2 CONSTRUCTION CHECKLIST REVIEW

- A. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.
- B. Return draft construction checklist review comments within 10 days of receipt.
- C. When review comments have been resolved, the CxA will provide final construction checklists, marked "Approved for Use, (date)."
- D. Use only construction checklists, marked "Approved for Use, (date)."

3.3 Cx TESTING PREPARATION

- A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved submittals.
- B. Certify that plumbing systems instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved submittals, and that pretest set points have been recorded.
- C. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

- A. Perform tests using design conditions, whenever possible.
 1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
 2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
 3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- B. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
- C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 Cx TESTS COMMON TO PLUMBING

- A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.
- B. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response according to acceptance criteria.
- C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
- D. Comply with construction checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Division 22 Sections specifying plumbing systems and equipment.
- E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:
 - 1. Construction checklist verification tests.
 - 2. Construction checklist verification test demonstrations.
 - 3. Cx tests.
 - 4. Cx test demonstrations.
- F. Vibration Isolation in Plumbing Systems:
 - 1. Prerequisites: Acceptance of results of construction checklists for vibration and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - 2. Components to Be Tested:
 - a. Vibration isolation and seismic control devices in plumbing systems.
 - b. Structural systems.
 - 3. Test Purpose: Evaluate effectiveness of vibration isolation and seismic control devices.
 - 4. Test Conditions: Measure vibration of the facility structure at three locations designated by Owner's witness while the isolated equipment operates.
 - 5. Test Conditions: Measure vibration of the facility structure at three locations designated by Owner's witness at the following operating conditions:
 - a. Maximum speed.
 - b. Minimum speed.
 - c. Critical speed.
 - 6. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.
- G. Supervision of Alarms in Plumbing Systems:
 - 1. Prerequisites: Acceptance of results of construction checklists for plumbing systems specified in the Sections listed below:
 - a. Section 226113 "Compressed-Air Piping for Laboratory Facilities."
 - 2. Scope:
 - a. Supervised plumbing system alarms.
 - 3. Purpose:
 - a. Verify reporting of supervised plumbing alarm at building management system.
 - 4. Conditions of the Test:
 - a. Alarm monitoring systems operating in normal, automatic mode.
 - b. Activate supervised plumbing alarms, one at a time.

5. Acceptance Criteria:
 - a. Activation of supervised plumbing alarm generates alarm at building management system control panel.

H. Plumbing Meter Reporting:

1. Prerequisites: Acceptance of results of construction checklists for plumbing systems specified in the Sections listed below:
 - a. Section 221119 "Domestic Water Piping Specialties."
2. Scope:
 - a. Supervised plumbing system water meters.
3. Purpose:
 - a. Verify accuracy of reporting of supervised plumbing system water meters at building management system.
4. Conditions of the Test:
 - a. Plumbing system water meter recording systems operating in normal, automatic mode.
 - b. Compare cumulative consumption data at plumbing system water meter recording systems with independent, calibrated flow-measuring instrumentation under the following conditions:
 - 1) Low Flow: 1 percent of maximum design flow rate for a period of four hours.
 - 2) High Flow: 80 percent of maximum design flow rate for a period of 20 minutes.
 - c. Activate supervised plumbing alarms, one at a time.
5. Acceptance Criteria:
 - a. Cumulative flow reported for low-flow condition is within 5 percent flow recorded by calibrated flow-measuring instrumentation.
 - b. Cumulative flow reported for high-flow condition is within 1 percent flow recorded by calibrated flow-measuring instrumentation.

3.6 Cx TESTS FOR COMPRESSED AIR SYSTEMS

A. Air Compressor Run Time:

1. Prerequisites:
 - a. Acceptance of results of construction checklists specified in the following:
 - 1) Section 226119 "Compressed-Air Equipment for Laboratory Facilities."
2. Scope:
 - a. Air compressors in plumbing systems.
 - b. Associated compressed air piping, valves, and appurtenances.
 - c. Associated air pressure controllers.
3. Purpose: Evaluate air compressor run time and number of compressor starts.
4. Conditions of the Test:
 - a. Keep compressed air openings closed during test.
 - b. For systems with multiple compressors, lock out compressor motors on all but one compressor. Repeat test for each compressor in turn.
 - c. Record number of air compressor motor starts during a 14-day period.
 - d. Record air compressor motor run time during the same 14-day period.
5. Acceptance Criteria:
 - a. Number of compressor motor starts during test period shall not exceed 20.
 - b. Compressor motor run time during test period shall not exceed 60 minutes.

3.7 Cx TESTS FOR VACUUM SYSTEMS

- A. Vacuum Pump Run Time:
1. Prerequisites:
 - a. Acceptance of results of construction checklists for vacuum equipment for laboratory and healthcare facilities.
 2. Scope:
 - a. Vacuum pumps in plumbing systems.
 - b. Associated vacuum piping, valves, and appurtenances.
 - c. Associated vacuum pressure controllers.
 3. Purpose:
 - a. Evaluate vacuum pump run time and number of vacuum pump starts.
 4. Conditions of the Test:
 - a. Keep vacuum piping openings closed during test.
 - b. For systems with multiple vacuum pumps, lock out vacuum pump motors on all but one pump. Repeat test for each vacuum pump in turn.
 - c. Record number of vacuum pump motor starts during a 14-day period.
 - d. Record vacuum pump motor run time during the same 14-day period.
 5. Acceptance Criteria:
 - a. Number of vacuum pump motor starts during test period shall not exceed 20.
 - b. Vacuum pump motor run time during test period shall not exceed 60 minutes.

3.8 Cx TESTS FOR PROCESSED WATER SYSTEMS

- A. Air Compressor Run Time:
1. Prerequisites: Acceptance of results of construction checklists specified for processed-water systems. Comply with requirements in Section 226700 "Processed Water Systems for Laboratory and Healthcare Facilities."
 2. Scope:
 - a. Processed water equipment in plumbing systems.
 - b. Associated processed water piping, valves, and appurtenances.
 - c. Processed water point-of-use fixtures.
 3. Purpose: Evaluate processed water quality at points-of-use.
 4. Conditions of the Test:
 - a. Operate water processing equipment and circulation pumps in normal automatic mode for seven days prior to the test.
 - b. Collect process water samples from points-of-use.
 - c. Collect and handle water samples according to analytical laboratory recommendations.
 - d. Document that the following parameters meet minimum standards required for the specified grade of process water, as applicable:
 - 1) Resistivity.
 - 2) Particle filtration.
 5. Acceptance Criteria:
 - a. Measured process water parameters shall meet the following criteria:
 - 1) Resistivity: 11 megohms.
 - 2) Particle Filtration: 1 micron.

END OF SECTION 220800

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
 - 2. Encasement for piping.

1.2 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Copper Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Viega LLC.
 - 2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

- H. Copper-Tube, Extruded-Tee Connections:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. T-Drill Industries Inc.
 - 2. Description: Tee formed in copper tube according to ASTM F 2014.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet.
- C. Color: Black or natural.

2.5 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Cascade Waterworks Manufacturing Co.
 - b. Dresser, Inc.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries, Inc.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc.
 - g. Viking Johnson.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following]:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.

- c. Spears Manufacturing Company.
 - 2. Description:
 - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket end.
- E. Plastic-to-Metal Transition Unions:
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Colonial Engineering, Inc.
 - b. NIBCO Inc.
 - c. Spears Manufacturing Company.
 - 2. Description:
 - a. CPVC or PVC four-part union.
 - b. Brass threaded end.
 - c. Solvent-cement-joint plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Flanges:
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Watts; a Watts Water Technologies company.
 - e. Wilkins.
 - 2. Standard: ASSE 1079.
 - 3. Factory-fabricated, bolted, companion-flange assembly.
 - 4. Pressure Rating: 125 psig minimum at 180 deg F.
 - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- C. Dielectric-Flange Insulating Kits:
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Nonconducting materials for field assembly of companion flanges.
 - 3. Pressure Rating: 150 psig .
 - 4. Gasket: Neoprene or phenolic.
 - 5. Bolt Sleeves: Phenolic or polyethylene.
 - 6. Washers: Phenolic with steel backing washers.
- D. Dielectric Nipples:
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products.

- c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
- 2. Standard: IAPMO PS 66.
 - 3. Electroplated steel nipple complying with ASTM F 1545.
 - 4. Pressure Rating and Temperature: 300 psig at 225 deg F
 - 5. End Connections: Male threaded or grooved.
 - 6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level without pitch and plumb.
- H. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- S. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- H. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, , ornipples.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

- 1. Close drain valves, hydrants, and hose bibbs.
- 2. Open shutoff valves to fully open position.
- 3. Open throttling valves to proper setting.
- 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
- 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
- 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
- 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
- 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- 3. Secondary disinfection is required for projects constructed in phases before building is turned over to the owner, to prevent Legionella and other pathogens growth in standing domestic water system.

B. Clean non-potable domestic water piping as follows:

- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
- 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

- a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water piping, NPS 3 and smaller, shall be the following:
- 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- E. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
- 1. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
- 1. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
- 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backflow preventers.
2. Water pressure-reducing valves.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Strainers.
6. Outlet boxes.
7. Hose stations.
8. Hose bibbs.
9. Wall hydrants.
10. Post hydrants.
11. Drain valves.
12. Water-hammer arresters.
13. Air vents.
14. Trap-seal primer valves.
15. Trap-seal primer systems.
16. Specialty valves.
17. Flexible connectors.
18. Water meters.

B. Related Requirements:

1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 224713 "Drinking Fountains" for water filters for water coolers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14. Mark "NSF-pw" on plastic piping components.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. FEBCO.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
 2. Standard: ASSE 1013.
 3. Operation: Continuous-pressure applications.
 4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 6. Configuration: Designed for horizontal, straight-through flow.
 7. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- B. Backflow-Preventer Test Kits :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Conbraco Industries, Inc.
 - b. FEBCO.
 - c. Flomatic Corporation.
 - d. Watts; a Watts Water Technologies company.
 - e. Zurn Industries, LLC.
 2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.4 WATER PRESSURE-REDUCING VALVES

- A. Water Regulators :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Honeywell Water Controls.
 - d. Watts; a Watts Water Technologies company.
 - e. Zurn Industries, LLC.
 2. Standard: ASSE 1003.
 3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
 4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.5 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :

- a. Armstrong International, Inc.
 - b. Tour & Andersson (Victaulic)
 - c. Flo Fab Inc.
 - d. ITT Corporation.
 - e. NIBCO Inc.
 - f. Schneider Electric USA, Inc.
 - g. TACO Incorporated.
 - h. Watts; a Watts Water Technologies company.
2. Type: Ball valve with two readout ports and memory-setting indicator.
 3. Body: Brass or bronze.
 4. Size: Same as connected piping, but not larger than NPS 2.
 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
 6. Size: Same as connected piping, but not smaller than NPS 2-1/2.
- B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- C. Memory-Stop Balancing Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Conbraco Industries, Inc.
 - b. Tour & Andersson (Victaulic)
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO Inc.
 - f. Red-White Valve Corporation.
 2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
 3. Pressure Rating: 400-psig minimum CWP.
 4. Size: NPS 2 or smaller.
 5. Body: Copper alloy.
 6. Port: Standard or full port.
 7. Ball: Chrome-plated brass.
 8. Seats and Seals: Replaceable.
 9. End Connections: Solder joint or threaded.
 10. Handle: Vinyl-covered steel with memory-setting device.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Primary, Thermostatic, Water Mixing Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Acorn Controls
 - b. Leonard Valve Company.
 - c. Powers; a division of Watts Water Technologies, Inc.
 2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig minimum unless otherwise indicated.
 4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded union inlets and outlet.
 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Tempered-Water Setting: 120 deg F.
 9. Valve Finish: Rough bronze.

2.7 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers :

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.8 OUTLET BOXES

A. Icemaker Outlet Boxes :

1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Sioux Chief.
 - b. Acorn Engineering Company.
 - c. Oatey.
2. Mounting: Recessed.
3. Material and Finish: Plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.9 HOSE STATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by the following :

1. Leonard Valve Company.
2. Strahman Valves, Inc.
3. T & S Brass and Bronze Works, Inc.

B. Single-Temperature-Water Hose Stations :

1. Standard: ASME A112.18.1.
2. Hose-Rack Material: Stainless steel.
3. Body Material: Bronze with stainless-steel wetted parts.
4. Body Finish: Rough bronze.
5. Mounting: Wall, with reinforcement.
6. Supply Fittings: NPS 3/4 gate, globe, or ball valve and check valve and [NPS 1/2] [NPS 3/4] copper, water tubing. Omit check valve if check stop is included with fitting.
7. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet long.
8. Nozzle: With hand-squeeze, on-off control.
9. Vacuum Breaker:
 - a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

- d. Watts; a Watts Water Technologies company.
 - e. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - f. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed -outlet, self-draining wall hydrants.
 3. Pressure Rating: 125 psig.
 4. Operation: Loose key.
 5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
 6. Inlet: NPS 3/4 or NPS 1.
 7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 8. Box: Deep, flush mounted with cover.
 9. Box and Cover Finish: Chrome plated.
 10. Operating Keys(s): Two with each wall hydrant.

B. Moderate-Climate Wall Hydrants :

1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - d. Watts; a Watts Water Technologies company.
 - e. Woodford Manufacturing Company.
 - f. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed -outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet:
 - a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Chrome plated.
9. Operating Keys(s): Two with each wall hydrant.

2.11 POST HYDRANTS

A. Freeze-Resistant Sanitary Yard Hydrants :

1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Woodford Manufacturing.
 - b. Or equal.
2. Standard: ASSE 1057, Type 5 for nondraining hydrants.
3. Operation: Wheel handle.
4. Head: Copper alloy, with pail hook.
5. Inlet: NPS 3/4-inch threaded inlet and inlet nozzle, galvanized-steel riser, and venturi.
6. Canister: Plastic with atmospheric-vent device.
7. Vacuum Breaker:
 - a. Removable hose-connection backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves :

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.13 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters :

1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. MIFAB, Inc.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.
 - e. Watts; a Watts Water Technologies company.
 - f. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.14 AIR VENTS

A. Bolted-Construction Automatic Air Vents :

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: [NPS 3/8] [NPS 1/2] minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents :

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.15 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device :

1. Manufacturers: Subject to compliance with requirements, provide products by the following :

- a. MIFAB, Inc.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.
 - e. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1018.
 3. Pressure Rating: 125 psig minimum.
 4. Body: Bronze.
 5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
 6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.16 TRAP-SEAL PRIMER SYSTEMS

- A. Trap-Seal Primer Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Precision Plumbing Products, Inc.
 2. Standard: ASSE 1044.
 3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
 4. Cabinet: Recessed -mounted steel box with stainless-steel cover.
 5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. Vacuum Breaker: ASSE 1001.
 7. Number Outlets: IOne or four.
 8. Size Outlets: NPS 1/2.

2.17 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following :
1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Flex Pression Ltd.
 4. Flex-Weld Incorporated.
 5. Hyspan Precision Products, Inc.
 6. Mercer Gasket & Shim, Inc.
 7. Metraflex Company (The).
 8. Proco Products, Inc.
 9. TOZEN Corporation.
 10. Unaflex.Universal Metal Hose.
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.18 WATER METERS

- A. Displacement-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Badger Meter.
 - b. ABB.
 - c. Carlon Meter.
 - d. Mueller Co.
 - e. Sensus.
 2. Description:
 - a. Standard: AWWA C700.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: Nutating disc; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. End Connections: Threaded.
- B. Compound-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, provide products by the following :
 - a. Badger Meter.
 - b. ABB.
 - c. Master Meter, Inc.
 - d. Mueller Co.
 - e. Sensus.
 2. Description:
 - a. Standard: AWWA C702.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: With integral mainline and bypass meters; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. Pipe Connections: Flanged.
- C. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
- D. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- C. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
- F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- I. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.
- J. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
- K. Install water-hammer arresters in water piping according to PDI-WH 201.
- L. Install air vents at high points of water piping.
- M. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- N. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- O. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Pressure vacuum breakers.
 2. Intermediate atmospheric-vent backflow preventers.
 3. Reduced-pressure-principle backflow preventers.
 4. Water pressure-reducing valves.

5. Calibrated balancing valves.
6. Primary, thermostatic, water mixing valves.
7. Outlet boxes.
8. Hose stations.
9. Supply-type, trap-seal primer valves.
10. Trap-seal primer systems.

- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. In-line, sealless centrifugal pumps.
 - 2. Vertically mounted, in-line, close-coupled centrifugal pumps.

1.2 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; a Xylem brand.
 - 3. Grundfos Pumps Corp.

4. TACO Incorporated.
- B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
- C. Pump Construction:
1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
 2. Casing: Bronze, with threaded or companion-flange connections.
 3. Impeller: Plastic.
 4. Motor: Single speed, unless otherwise indicated.

2.2 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
1. Armstrong Pumps, Inc.
 2. Bell & Gossett; a Xylem brand.
 3. Grundfos Pumps Corp.
 4. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
- B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
 2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
 3. Shaft and Shaft Sleeve: Stainless-steel or steel shaft, with copper-alloy shaft sleeve.
 4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
 5. Bearings: Oil-lubricated; bronze-journal or ball type.
 6. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
- D. Motor: Single speed, with grease-lubricated ball bearings; and rigidly mounted to pump casing.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
1. Type: Water-immersion temperature sensor, for installation in piping.
 2. Range: 65 to 200 deg F .
 3. Enclosure: NEMA 250, Type 4X.
 4. Operation of Pump: On or off.
 5. Transformer: Provide if required.
 6. Power Requirement: 24 V.
- B. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
 2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
 3. Operation of Pump: On or off.
 4. Transformer: Provide if required.
 5. Power Requirement: 24-V ac .
 6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days .
- C. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.
1. Type: Adjustable time-delay relay.
 2. Range: Up to five minutes.
 3. Setting: Five minutes.
 4. Enclosure: NEMA 250, Type 4X .
 5. Operation of Pump: On or off.
 6. Transformer: Provide if required.
 7. Power Requirement: 24-V ac .
 8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.
- C. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft(s) horizontal.
- D. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.
- E. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support pump weight.
1. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
 2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- F. Install pressure switches in water supply piping.
- G. Install thermostats in hot-water return piping.
- H. Install timers on wall in engineer's office.
- I. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to pumps to allow service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
 - b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
 - c. Vertically mounted, in-line, close-coupled centrifugal pumps.
 - d. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
- D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties."
 - 1. Install pressure gage at suction of each pump and pressure gage at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- E. Connect pressure switches, thermostats, time-delay relays, timers to pumps that they control.
- F. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
 - 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 7. Start motor.
 - 8. Open discharge valve slowly.
 - 9. Adjust temperature settings on thermostats.
 - 10. Adjust timer settings.

3.6 ADJUSTING

- A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Encasement for underground metal piping.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.
- B. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Mission Rubber Company; a division of MCP Industries, Inc.
 - c. Tyler Pipe.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 CPVC PIPE AND FITTINGS

- A. CPVC Pipe: ASTM F 2618, Schedule 40.
- B. CPVC Fittings: ASTM F 2618, drain, waste, and vent patterns.
 - 1. Solvent Cement: ASTM F 493.

2.4 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.
- D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

2.5 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.6 ENCASUREMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: Linear low-density polyethylene film of 0.008-inch minimum thickness.
- C. Form: Sheet.

- D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. Install underground CPVC piping in accordance with ASTM D 2321 and ASTM F 1668.
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- B. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- C. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join in accordance with ASTM D 2855 appendix.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Install hangers for cast-iron, steel, stainless steel, and copper soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers CPVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- D. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.
- E. Support vertical runs of cast-iron, steel, stainless steel, and copper soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support vertical runs CPVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 3. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
- C. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- D. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

FIELD QUALITY CONTROL

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water (30 kPa head of water).
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg (250 Pa).
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action

CLEANING AND PROTECTION

3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Repair damage to adjacent materials caused by waste and vent piping installation.
- E. PIPING SCHEDULE
- F. Aboveground, soil and waste piping NPS 4 and smaller are to be the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- G. Above ground, soil and waste piping NPS 4 and smaller are to be the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- H. Aboveground, vent piping NPS 4 and smaller are to be the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- I. Underground, soil and waste piping NPS 4 and smaller are to be the following:
 1. CPVC drainage piping and solvent-cemented joints.

FIELD QUALITY CONTROL

FIELD QUALITY CONTROL

END OF SECTION

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Miscellaneous sanitary drainage piping specialties.
- B. Related Requirements:
 - 1. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
 - 2. Section 077200 "Roof Accessories" for preformed flashings.
 - 3. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
 - 4. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile butadiene styrene.
- B. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.

- b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
 3. Size: Same as connected drainage piping
 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 5. Closure: Countersunk, cast-iron plug.
 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Cast-Iron Exposed Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
 3. Size: Same as connected branch.
 4. Type: Heavy-duty, adjustable housing.
 5. Clamping Device: Required.
 6. Outlet Connection: Inside calk.
 7. Closure: Brass plug with straight threads and gasket.
 8. Adjustable Housing Material: Cast iron with [threads] [setscrews or other device].
 9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 10. Frame and Cover Shape: Round.
 11. Top-Loading Classification: Heavy Duty.
 12. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- B. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 2. Body: Bronze or cast iron.
 3. Inlet: Opening in top of body.
 4. Outlet: Larger than inlet.
 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- C. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
 2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- E. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- F. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- G. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- H. Install wood-blocking reinforcement for wall-mounting-type specialties.
- I. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Floor sinks.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene styrene.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.
- F. PVC: Polyvinyl chloride.

ACTION SUBMITTALS

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Standard: ASME A112.6.3.
 - 3. Pattern: Floor drain.
 - 4. Body Material: Gray iron.
 - 5. Seepage Flange: Not required.
 - 6. Anchor Flange: Required.
 - 7. Clamping Device: Required.
 - 8. Outlet: Bottom.
 - 9. Backwater Valve: Not required.
 - 10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
 - 11. Sediment Bucket: Not required.
 - 12. Top or Strainer Material: Nickel bronze.
 - 13. Top of Body and Strainer Finish: Nickel bronze.
 - 14. Top Shape: Round.
 - 15. Top Loading Classification: Heavy Duty .

16. Funnel: Not required.
17. Inlet Fitting: Not required.
18. Trap Material: Cast iron.
19. Trap Pattern: Standard P-trap.
20. Trap Features: Trap-seal primer valve drain connection.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Not required.
10. Internal Strainer: Dome.
11. Internal Strainer Material: Aluminum.
12. Top Grate Material: Cast iron.
13. Top of Body and Grate Finish: Nickel bronze.
14. Top Shape: Square.
15. Funnel: Not required. Insert material, shape and dimensions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
- B. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
- C. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
- B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. Ideal Tridon.
 - e. MIFAB, Inc.
 - f. Mission Rubber Company; a division of MCP Industries, Inc.
 - g. Stant.
 - h. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 CPVC PIPE AND FITTINGS

- A. CPVC Pipe: ASTM F 2618, Schedule 40.
- B. CPVC Fittings: ASTM F 2618, drain, waste, and vent patterns.
- C. Solvent Cement: ASTM F 493.

2.4 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company; a division of MCP Industries, Inc.
 - 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Dielectric Fittings:
 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
 2. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Capitol Manufacturing Company.
 - 2) Central Plastics Company.
 - 3) Matco-Norca, Inc.

- 4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 5) Wilkins; a Zurn company.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel-backing washers.
4. Dielectric Nipples:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following]]:
 - 1) Grinnell Mechanical Products.
 - 2) Matco-Norca, Inc.
 - 3) Precision Plumbing Products, Inc.
 - 4) Victaulic Company.
 - b. Description:
 - 1) Electroplated steel nipple complying with ASTM F 1545.
 - 2) Pressure Rating: 300 psig at 225 deg F.
 - 3) End Connections: Male threaded or grooved.
 - 4) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- O. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
 - 2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- C. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. CPVC Piping: Join according to ASTM F 493.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Shielded, nonpressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
 - 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.
 - 4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Section 220523.12 "Ball Valves for Plumbing Piping," and Section 220523.14 "Check Valves for Plumbing Piping."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 6. Individual, Straight, Horizontal Piping Runs:

- a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- I. Install supports for vertical CPVC piping every 48 inches.
- J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 2. Comply with requirements for cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.

3.10 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

- A. Aboveground storm drainage piping NPS 6 and smaller shall be the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
- B. Aboveground, storm drainage piping NPS 8 and larger shall be the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.

- C. Underground storm drainage piping NPS 6 and smaller shall be the following:
 - 1. CPVC pipe, CPVC socket fittings, and solvent-cemented joints.

- D. Underground, storm drainage piping NPS 8 and larger shall be the following:
 - 1. CPVC pipe, CPVC socket fittings, and solvent-cemented joints.

END OF SECTION

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. General-purpose roof drains.
 - 2. Miscellaneous storm drainage piping specialties.
 - 3. Cleanouts.
- B. Related Requirements:
 - 1. Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.
 - 2. Section 078413 "Penetration Firestopping" for firestopping roof penetrations.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Provide drainage piping specialties are to bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 GENERAL-PURPOSE ROOF DRAINS

- A. Cast-Iron Roof Drains:
- B. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Watts Water Technologies; a Watts company.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.4.
 - 3. Body Material: Cast iron.
 - 4. Dimension of Body: Nominal 14-to 16-inch diameter.
 - 5. Dome Material: Cast iron.
 - 6. Combination flashing ring and gravel stop.
 - 7. Outlet: Bottom (See plumbing drawing fixture schedule).
 - 8. Outlet Type: No-hub.
 - 9. Provide roof drain extension as required to get roof drain to final height required for roofing.
 - 10. Provide the following options as required to complete the installation:
 - a. Flow-control weirs.
 - b. Extension collars.
 - c. Underdeck clamp.
 - d. Expansion joint.
 - e. Sump receiver plate.
 - f. Vandal-proof dome.
 - g. Minimum 2 inches high water dam. (On Secondary overflow roof drains).

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

2.3 Downspout Adapters:

- A. Metal Downspout Nozzles:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Watts Water Technologies; a Watts company.
 - c. Zurn Industries, LLC.
 2. Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor.
 3. Size: Same as connected downspout.
 4. Material: Cast bronze or nickel bronze nozzle and flange.
 5. Piping Connection Type: Threaded unless otherwise noted in the plumbing drawing fixture schedule.
 6. Finish: See plumbing drawing fixture schedule.
 7. Opening Protection: Birdscreen unless otherwise noted in the plumbing drawing fixture schedule.

2.4 CLEANOUTS

- A. Cast-Iron Cleanouts:
1. Cast-Iron Exposed Cleanouts:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Jay R. Smith Mfg Co; a division of Morris Group International.
 - 2) Watts Water Technologies; a Watts company.
 - 3) Zurn Industries, LLC.
 - b. Standard: ASME A112.36.2M.
 - c. Size: Same as connected branch.
 - d. Body Material: No-hub, cast-iron soil pipe test tee as required to match connected piping.
 - e. Closure: Countersunk or raised-head, brass or cast-iron plug.
 - f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.
 2. Cast-Iron Exposed Floor Cleanouts:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Jay R. Smith Mfg Co; a division of Morris Group International.
 - 2) Watts Water Technologies; a Watts company.
 - 3) Zurn Industries, LLC.
 - b. Standard: ASME A112.36.2M.
 - c. Size: Same as connected branch.
 - d. Type: Heavy-duty, adjustable housing unless otherwise noted in the plumbing drawing fixture schedule.
 - e. Body or Ferrule: Cast iron.
 - f. Outlet Connection: No-hub unless otherwise noted in the plumbing drawing fixture schedule.
 - g. Closure: Brass plug with straight threads and gasket unless otherwise noted in the plumbing drawing fixture schedule.
 - h. Adjustable Housing Material: Cast iron with threads, setscrews or other device unless otherwise noted in the plumbing drawing fixture schedule.
 - i. Frame and Cover Material and Finish: Nickel-bronze, copper alloy unless otherwise noted in the plumbing drawing fixture schedule.
 - j. Frame and Cover Shape: Round.
 - k. Top Loading Classification: Extra-Heavy Duty unless otherwise noted in the plumbing drawing fixture schedule.
 - l. Riser: ASTM A74, Extra-Heavy Class, cast-iron drainage pipe fitting and riser to cleanout unless otherwise noted in the plumbing drawing fixture schedule.

3. Cast-Iron Wall Cleanouts:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Jay R. Smith Mfg Co; a division of Morris Group International.
 - 2) Watts Water Technologies; a Watts company.
 - 3) Zurn Industries, LLC.
 - b. Standard: ASME A112.36.2M. Include wall access.
 - c. Size: Same as connected drainage piping.
 - d. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
 - e. Closure Plug:
 - 1) Material: Brass or Cast iron.
 - 2) Head: Countersunk or raised.
 - 3) Drilled and threaded for cover attachment screw.
 - 4) Size: Same as, or not more than, one size smaller than cleanout size.
 - f. Wall-Access Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw unless otherwise noted in the plumbing drawing fixture schedule.
 - g. Wall-Access Frame and Cover: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover unless otherwise noted in the plumbing drawing fixture schedule.
4. Cast-Iron Test Tees:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Jay R. Smith Mfg Co; a division of Morris Group International.
 - 2) Watts Water Technologies; a Watts company.
 - 3) Zurn Industries, LLC.
 - b. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
 - c. Size: Same as connected drainage piping.
 - d. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
 - e. Closure Plug: Countersunk or raised head, brass.
 - f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.
 1. Install flashing collar or flange of roof drain to maintain integrity of waterproof membranes where penetrated.
 2. Install expansion joints, if indicated, in roof drain outlets.
 3. Position roof drains for easy access and maintenance.
 4. Provide roof drain extension as required to get roof drain to final height required for roofing.
- B. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.
- C. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:
 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate cleanouts at each change in direction of piping greater than 135 degrees.
 3. Locate cleanouts at minimum intervals of 50 ft. for piping NPS 4 and smaller and 100 ft. for larger piping.

4. Locate cleanouts at base of each vertical storm piping conductor.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install test tees in vertical conductors and near floor.
- G. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- H. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
 1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 INSTALLATION OF FLASHING

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.

3.4 CLEANING

- A. Clean piping specialties during installation and remove dirt and debris as work progresses.

3.5 PROTECTION

- A. Protect piping specialties during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day and when work stops.

END OF SECTION 221423

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Commercial, electric, storage, domestic-water heaters.
 - 2. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 3. Thermostat-control, electric, tankless, domestic-water heaters.
 - 4. Domestic-water heater accessories.

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For commercial domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Three years.
 - b. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Two years.
 - c. Electric, Tankless, Domestic-Water Heaters: Two year(s).
 - d. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Water Heaters.
 - b. Bradford White Corporation.
 - c. PVI Industries, LLC.
 - d. RECO USA.
 - e. Rheem Manufacturing Company.
 - f. Smith, A. O. Corporation
 - g. State Industries.
 - h. Standard: UL 1453.
 - 2. Storage-Tank Construction: ASME-code, steel vertical arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: 150 psig.

- c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
 - 4. Special Requirements: NSF 5 construction.
- B. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Water Heaters.
 - b. Bradford White Corporation.
 - c. Rheem Manufacturing Company.
 - d. Smith, A. O. Corporation.
 - e. State Industries.
 - 2. Standard: UL 174.
 - 3. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1.
 - e. Jacket: Steel with enameled finish.
 - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation unless otherwise indicated. Limited to 12 kW total.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
 - 5. Special Requirements: NSF 5 construction with legs for off-floor installation.

2.2 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

- A. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Bosch Water Heating.

- b. Chronomite Laboratories, Inc.
 - c. E-Tankless Water Heaters Corp.
 - d. Keltech, Inc.
2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
 3. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Thermostat.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 4. Support: Bracket for wall mounting.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Bell & Gosset.
 - b. AMTROL Inc.
 - c. Smith, A. O. Corporation.
 - d. State Industries.
 - e. Taco, Inc.
 2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- D. Heat-Trap Fittings: ASHRAE 90.2.
- E. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.
- F. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- G. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- I. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

- J. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
- K. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- C. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.13 "Butterfly Valves for Plumbing Piping,"
- D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- H. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- I. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- J. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.13 "Butterfly Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- K. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."
- L. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- M. Fill electric, domestic-water heaters with water.
- N. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial and tankless, electric, domestic-water heaters.

END OF SECTION

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Wall-mounted water closets.
 2. Flushometer valves.
 3. Toilet seats.
 4. Supports.

1.2 DEFINITIONS

- A. High-Efficiency Flush Volume: 1.28 gal. or less per flush.
- B. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.3 ACTION SUBMITTALS

- A. Product Data:
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Standards:
1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
 2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
 3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
 4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
 5. Comply with ASME A112.6.1M for water-closet supports.
 6. Comply with ICC A117.1 for ADA-compliant water closets.

7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 WALL-MOUNTED WATER CLOSETS

A. Water Closets - Wall Mounted, Top Spud:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. Sloan Valve Company.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC.
2. Source Limitations: Obtain water closets from single source from single manufacturer.
3. Bowl:
 - a. Material: Vitreous china.
 - b. Type: Siphon jet.
 - c. Style: Flushometer valve.
 - d. Mounting Height: See fixture schedule on drawings.
 - e. Rim Contour: Elongated.
 - f. Water Consumption: Maximum 1.28 gal. per flush.
 - g. Spud Size and Location: NPS 1-1/2; top.
 - h. Color: White.
4. Flushometer Valve: See flushometer valve paragraph.
5. Toilet Seat: See toilet seat paragraph below.
6. Support: See Water-closet carrier paragraph below.

2.3 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm, Lever Handle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sloan Valve Company.
 - b. Zurn Industries, LLC.
2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Style: Exposed.
7. Flushometer-Valve Finish: Chrome-plated.
8. Handle Finish: Chrome-plated, Antimicrobial.
9. Consumption: Maximum 1.28 gal. per flush. See plumbing drawing fixture schedule.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.

B. Flushometer Valves - Diaphragm, Solenoid Actuated:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sloan Valve Company.
 - b. Zurn Industries, LLC.
2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.

6. Style: See plumbing drawing fixture schedule.
7. Exposed Flushometer-Valve Finish: Chrome-plated.
8. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
9. Trip Mechanism: Hard-wired in the plumbing drawing fixture schedule; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
10. Consumption: Maximum 1.28 gal.per flush. See plumbing drawing fixture schedule.
11. Minimum Inlet: NPS 1.
12. Minimum Outlet: NPS 1-1/4.

2.4 TOILET SEATS

A. Toilet Seats: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Bemis Manufacturing Company.
 - c. Centoco Manufacturing Corporation.
 - d. Church Seats; Bemis Manufacturing Company.
 - e. Kohler Co.
 - f. TOTO USA, INC.
 - g. Zurn Industries, LLC.
2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.
10. Surface Treatment: Antimicrobial.

2.5 SUPPORTS

A. Water-Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Water-Closet Installation:
1. Install level and plumb.
 2. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.
- B. Support Installation:
1. Use carrier supports with waste-fitting assembly and seal.
 2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
 3. Measure support height installation from finished floor, not structural floor.
- C. Flushometer-Valve Installation:
1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
 4. Install actuators in locations easily reachable for people with disabilities.
- D. Install toilet seats on water closets.
- E. Wall Flange and Escutcheon Installation:
1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- F. Joint Sealing:
1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 2. Match sealant color to water-closet color.
 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

- C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.7 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224213.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Urinals.
 - 2. Flushometer valves.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 URINALS

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. TOTO USA, INC.
 - d. Zurn Industries, LLC; Commercial Brass and Fixtures..
- 2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
- 3. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

2.2 URINAL FLUSHOMETER VALVES

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Sloan Valve Company.

- b. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - c. American Standard.
 - d. TOTO USA
2. Standard: ASSE 1037.
 3. Minimum Pressure Rating: 125 psig.
 4. Features: Include integral check stop and backflow-prevention device.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Urinal Installation:
 1. Install urinals level and plumb according to roughing-in drawings.
 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
 3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
- B. Support Installation:
 1. Install supports, affixed to building substrate, for wall-hung urinals.
 2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
 3. Use carriers without waste fitting for urinals with tubular waste piping.
 4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
- C. Flushometer-Valve Installation:
 1. Install flushometer-valve water-supply fitting on each supply to each urinal.
 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
- D. Wall Flange and Escutcheon Installation:
 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- E. Joint Sealing:
 1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 2. Match sealant color to urinal color.
 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vitreous-china, counter-mounted lavatories.
 - 2. Vitreous-china, wall-mounted lavatories.
 - 3. Automatically operated lavatory faucets.
 - 4. Supply fittings.
 - 5. Waste fittings.
 - 6. Lavatory supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Servicing and adjustments of automatic faucets.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory - Vitreous China, Undercounter Mounted :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.

- c. TOTO USA, INC.
- 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For undercounter mounting.
 - c. Color: White.
 - d. Mounting Material: Sealant and undercounter mounting kit.

2.2 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory - Vitreous China, Wall Mounted:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. TOTO USA, INC.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Color: White.
 - d. Mounting Material: Wall carrier.
 - 3. Support: Type II, concealed-arm lavatory carrier with escutcheons.
 - 4. Lavatory Mounting Height: Handicapped/elderly in accordance with ICC A117.1.
 - 5. Support: Type III lavatory carrier with two hanger plates made for corner lavatories.
- B. Lavatory Mounting Height: Handicapped/elderly in accordance with ICC A117.

2.3 AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets - Automatic Type: Hardwired Electronic Sensor Operated:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. Sloan Valve Company.
 - 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 - 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 - 5. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
 - 6. Finish: Polished chrome plate.
 - 7. Maximum Flow Rate: 0.5 gpm.
 - 8. Drain: Not part of faucet.

2.4 SUPPLY FITTINGS

- A. Products shall comply with the SDWA (Safe Drinking Act) "No Lead" restrictions of ANSI NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.

- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with brass stems and shall contain no plastics.
- E. 1/2" IPS inlet connection and outlet 3/8" compression.
- F. Operation: Loose key

2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with offset and straight tailpiece.
 - 1. Size: NPS 1-1/4 (DN 32)
 - 2. Material:
 - a. Chrome plated cast brass strainer (with or without overflow) and brass lock nut.
 - b. 17-gauge seamless brass tube drain tailpiece.
 - c. CSA certified or other recognized third party testing authority.
 - d. Marked with manufacturers name.
- C. Trap:
 - 1. Size: NPS 1-1/2 by NPS 1-1/4.
 - 2. Material:
 - a. Chrome plated heavy cast brass with cleanout.
 - b. 17-gauge seamless brass adjustable wall bend.
 - c. Include cast brass, slip joints nuts and no reducing washers.
 - d. CSA certified or other recognized third party testing authority.

2.6 LAVATORY SUPPORTS

- A. Lavatory Wall Carrier:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.
 - 3. General: Provide with steel uprights and floor anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb in accordance with roughing-in drawings.
- B. Install wall carriers, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.

- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Service basins.
 - 2. Breakroom sinks.
 - 3. Supply fittings.
 - 4. Waste fittings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
 - 2. Include rated capacities, operating characteristics and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sinks to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

- A. Service Basins: Terrazzo, floor mounted.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Acorn Engineering Company.
 - b. Crane Plumbing, L.L.C.
 - c. Florestone Products Co., Inc.
 - d. Stern-Williams Co., Inc.
 - 2. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Square.
 - c. Nominal Size: 24 by 36 inches
 - d. Height: 12 inches with dropped front.
 - e. Rim Guard: On front] top surface.
 - f. Drain: Grid with NPS 3 outlet.

3. Mounting: On floor and flush to wall.

B. Service Basins : Plastic, floor mounted.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

- a. Crane Plumbing, L.L.C..
- b. E. L. Mustee & Sons, Inc.
- c. Florestone Products Co., Inc.
- d. FNW; Ferguson Enterprises, Inc.; ProFlo Brand.
- e. Swan Corporation (The).
- f. Zurn Industries, LLC; Light Commercial Specialty Plumbing Products.

2. Fixture:

- a. Standard: IAPMO/ANSI Z124.6.
- b. Material: Cast polymer.
- c. Nominal Size: 24 by 36 by 10 inches.
- d. Rim Guard: On fronttop surfaces.
- e. Drain: Grid with NPS 3 outlet.

3. Mounting: On floor and flush to wall.

2.2 BREAKROOM SINKS

A. Breakroom Sinks : Stainless steel, two bowl, counter mounted.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

- a. Elkay Manufacturing Co.
- b. Just Manufacturing.

2. Fixture:

- a. Standard: ASME A112.19.3/CSA B45.4.
- b. Type: Self-rimming.
- c. Material: Stainless steel.
- d. Nominal Size: Approximately 22 by 42 inches.

3. Faucet: .

- a. Location: On bowl.

4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

5. Waste Fittings:

- a. Standard: ASME A112.18.2/CSA B125.2.
- b. Bowl:

- 1) Drain: Cup with stopper and NPS 1-1/2 tailpiece.
- 2) Drain Piping: NPS 1-1/2 chrome-plated, tubular-brass direct waste without trap, separate waste piping, and wall flange.

c. Opposite Bowl:

- 1) Drain: Grid with stopper and NPS 1-1/2 tailpiece.
- 2) Trap:

- a) Size: NPS 1-1/2.
- b) Material: Comply with requirements in "Waste Fittings" Article.

2.3 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

- B. Sink Faucets : Manual type, two-lever-handle mixing valve.
 - 1. Commercial, Solid-Brass Faucets.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1) American Standard America.
 - 2) Bradley Corporation.
 - 3) Chicago Faucets; Geberit Company.
 - 4) Delta Faucet Company.
 - 5) Elkay Manufacturing Co.
 - 6) GROHE America, Inc.
 - 7) Just Manufacturing.
 - 8) Kohler Co.
 - 9) Moen Incorporated.
 - 10) Speakman Company.
 - 11) Symmons.
 - 12) T & S Brass and Bronze Works, Inc.
 - 13) Zurn Industries, LLC.

2.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
 - 1. Size: NPS 1-1/2.

2.6 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224713 - DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes drinking fountains and related components.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of drinking fountain.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include operating characteristics, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

- a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1) Elkay.
 - 2) Haws Corporation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set pedestal drinking fountains on floor.
- C. Install recessed drinking fountains secured to wood blocking in wall construction.
- D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."

- F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

- A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 226113 - COMPRESSED-AIR PIPING FOR LABORATORY FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air."
- B. Related Requirements:
 - 1. Section 226119 "Compressed-Air Equipment for Laboratory Facilities" for air compressors and specialties.

1.2 DEFINITIONS

- A. Nonmedical compressed-air piping systems include laboratory air piping systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Laboratory air operating at 100 psig.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Medical compressed-air manifolds shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

2.3 PIPES, TUBES, AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K, seamless, drawn-temper, water tube.
 - 1. Press-Type Fittings, NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - 2. Press-Type Fittings: NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Viega; Plumbing and Heating Systems.
- B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be jointed.

2.4 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.
- C. Metal Vall, Butterfly, and Check Valves: Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.14 "Check Valves for Plumbing Piping."

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and specialties to allow service and maintenance.
- F. Install compressed-air piping with 1 percent slope downward in direction of flow.
- G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- H. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- I. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

- J. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."
- K. Install piping to permit valve servicing.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and for branch connections.
- N. Install medical air piping to medical air service connections specified in this Section, to medical air service connections in equipment specified in Section 226313 "Gas Piping for Laboratory Facilities," and to equipment specified in other Sections requiring medical air service.
- O. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

3.2 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.14 "Check Valves for Plumbing Piping."
- B. Install shutoff valve at each connection to and from compressed-air equipment and specialties.

3.3 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.
- C. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operations qualified according to Part 1 "Quality Assurance" Article.
- D. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or Type 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.

- G. Support horizontal piping within 12 inches of each fitting and coupling.
- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch-minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
 - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
 - 9. NPS 3: 14 feet with 1/2-inch rod.
 - 10. NPS 3-1/2: 15 feet with 1/2-inch rod.
 - 11. NPS 4: 16 feet with 1/2-inch rod.
 - 12. NPS 5: 18 feet with 1/2-inch rod.
 - 13. NPS 6: 20 feet with 5/8-inch rod.
 - 14. NPS 8: 23 feet with 3/4-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.

3.5 IDENTIFICATION

- A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL FOR COMPRESSED-AIR PIPING IN NONMEDICAL LABORATORY FACILITIES

- A. Perform field tests and inspections.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill compressed-air piping with oil-free dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - 2. Repair leaks and retest until no leaks exist.
 - 3. Inspect filters and pressure regulators for proper operation.
- C. Prepare test reports.

3.7 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.8 PIPING SCHEDULE

- A. Connect new tubing to existing tubing with memory-metal couplings.
- B. Flanges may be used where connection to flanged equipment is required.
- C. Laboratory Air Piping:
 - 1. Type L, copper tube, press-type fittings; and pressure-sealed joints.

3.9 VALVE SCHEDULE

- A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Articles in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.14 "Check Valves for Plumbing Piping."

END OF SECTION

SECTION 226119 - COMPRESSED-AIR EQUIPMENT FOR LABORATORY FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Scroll air compressors.

1.2 DEFINITIONS

- A. Actual Air: Air delivered at air-compressor outlet. Flow rate is compressed air delivered and measured in acfm.
- B. Laboratory Air Equipment: Compressed-air equipment and accessories for nonmedical laboratory facilities.
- C. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For air compressors, compressed-air dryers, and compressed-air purification systems.
 - 1. Include plans, elevations, sections, and[mounting] details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Seismic Qualification Certificates: For air compressors, accessories, and components from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For compressed-air equipment to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Air-Compressor, Inlet-Air Filter Elements: Equal to 50 percent of quantity installed, but no fewer than 2 units.
 - 2. Belts: One for each belt-driven compressor.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Laboratory Air Equipment for Nonmedical Laboratory Facilities: An employer of workers trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Air compressors and accessories shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 GENERAL REQUIREMENTS FOR AIR COMPRESSORS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
- C. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 - 2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 - 6. Automatic control switches to alternate lead-lag air compressors for duplex and sequence lead-lag air compressors for multiplex air compressors.
 - 7. Instrumentation: Include discharge-air and receiver pressure gages, air-filter maintenance indicator, hour meter, air-compressor discharge-air and coolant temperature gages, and control transformer.
 - 8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
- D. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 1. Pressure Rating: At least as high as highest discharge pressure of connected air compressors and bearing appropriate code symbols.
 - 2. Interior Finish: Corrosion-resistant coating.
 - 3. Accessories: Include safety valve, pressure gage, automatic drain, and pressure regulator.

- E. Mounting Frame: Fabricate base and attachment to air compressor and components with reinforcement strong enough to resist movement during a seismic event when base is anchored to building structure.

2.3 SCROLL AIR COMPRESSORS

A. Packaged Scroll Air Compressor System :

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Powerex.
 - b. Patton's Medical.
2. Description: Duplex-compressor packaged unit, complete with corrosion-resistant air receiver, dessicant air dryer with purge control, control panel, and dew point monitor.
3. Air Compressor(s): Single-stage, belt-driven, oil-free, rotary, oscillating-volute type of construction that prohibits oil from entering compression chamber; compressor bearings shall be external to air compression chamber for accessibility, integral radial flow fan for cooling, flexible connectors on intake and discharge, discharge check valve, fan-cooled aftercooler, condensate separator, and high discharge temperature shut down switch.
4. Motor: Belt-driven, ODP, NEMA construction motor; OSHA approved belt gaurds.
5. Air Receiver: ASME air receiver rated for 200 psi MAWP; provided with pressure gauge and safety relief valve, bypass valves, sight gauge, and automatic tank drain with manual override.
6. Control Panel: Provide lead/lag sequencing and automatic alternation of all compressors for equal run time. Include gateway server card; building automation communication with BacNet protocol and Web server features, ethernet port for connection to BacNet server or direct connection, UL508-A control panel in a NEMA 4 enclosure, color touch-screen display, and dry contacts for remote monitoring of all system alarms.
7. Air Purification: Dual desiccant air dryers, dual filter and regulator bank with sample ports, and dew point monitor with alarms, and all bypass piping. Piping to be cleaned for medical air use; all components shall be mounted piped and wired to the air receiver.
8. Desiccant Air Dryer: Dual dryers each sized to meet full airflow requirement of the system and designed for a dew point of -40 degrees Fahrenheit. Automatic pressure swing, heatless, regenerative type with solid state cycle timer, switching valve design, and purge muffler.
9. Filtration and Pressure Reducing Station: Each assembly shall be provided with bypass valves, sampling port, and dual set of pressure reducing valves with pressure gauges downstream of final filters; two-stage filtration with centrifugal water separation and 5-micron filter element with element coalescing vibration or 0.01 micron or finer pre-filter with element change indication and automatic condensate drain installed upstream of air dryer, second state shall include 1-micron particulate filter with element change indicator installed downstream of air dryer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean compressed-air equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for laboratory air applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

3.2 COMPRESSED-AIR EQUIPMENT INSTALLATION

- A. General Requirements for Compressed-Air Equipment Installation:
 1. Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.
 2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.

3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
4. Install equipment to allow right of way for piping installed at required slope.
5. Install the following devices on compressed-air equipment:
 - a. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
 - b. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.
 - c. Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.3 CONNECTIONS

- A. Comply with requirements for drain piping specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for compressed-air piping specified in Section 226113 "Compressed-Air Piping for Laboratory Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Where installing piping adjacent to equipment, allow space for service and maintenance.
- D. Connect compressed-air piping to compressed-air equipment, accessories, and specialties with shutoff valve and union or flanged connection.

3.4 IDENTIFICATION

- A. Identify nonmedical laboratory compressed-air equipment system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Check for lubricating oil in lubricated-type equipment.
 3. Check belt drives for proper tension.
 4. Verify that air-compressor inlet filters and piping are clear.
 5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
 6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure, but not higher than rating of system components.
 7. Check for proper seismic restraints.
 8. Drain receiver tank(s).
 9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 10. Test and adjust controls and safeties.
- B. Prepare written report documenting testing procedures and results.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors, compressed-air dryers compressed-air purification units and compressed-air filter assemblies.

END OF SECTION

SECTION 226213 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Laboratory vacuum piping, designated "laboratory vacuum."
- B. Related Requirements:
 - 1. Section 226219 "Vacuum Equipment for Laboratory Facilities" for vacuum producers and accessories.

1.2 DEFINITIONS

- A. Nonmedical laboratory vacuum piping systems include laboratory vacuum piping systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Pressure-Seal Joining Procedure for Copper Tubing: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Laboratory vacuum operating at 19 in. Hg.

2.2 PIPES, TUBES, AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K, seamless, drawn-temper, water tube.
 - 1. Press-Type Fittings, NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring sea in each end.

2. Press-Type Fittings: NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Viega; Plumbing and Heating Systems.
- B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be jointed.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, vacuum producer sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and specialties to allow service and maintenance.
- F. Install vacuum piping with 1 percent slope downward in direction of flow.
- G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- H. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- I. Provide drain leg and drain trap at end of each main and branch and at low points.
- J. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."
- K. Install piping to permit valve servicing.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
- N. Piping Restraint Installation: Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- O. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

3.2 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Apply appropriate tape to external pipe threads.
- E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" chapter. Do not use flux. Continuously purge joint with oil-free dry nitrogen during brazing.
- F. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by tube manufacturer.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or Type 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- (10-mm-) minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 - 4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 - 5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
 - 6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
 - 7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.

8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

- J. Install supports for vertical copper tubing every 10 feet (3 m).

3.5 IDENTIFICATION

- A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

- A. Tests and Inspections:

1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - a. Test Pressure for Copper Tubing: 100 psig.
2. Repair leaks and retest until no leaks exist.
3. Inspect filters for proper operation.

- B. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.7 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.8 PIPING SCHEDULE

- A. Connect new copper tubing to existing copper tubing with memory-metal couplings.
- B. Flanges may be used where connection to flanged equipment is required.
- C. Laboratory Vacuum Piping: Use the following piping materials for each size range:
 1. NPS 4 and Smaller: Type L, copper tube, press-type fittings; and pressure-sealed joints.

3.9 VALVE SCHEDULE

- A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Articles in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.14 "Check Valves for Plumbing Piping."

END OF SECTION

SECTION 226219 - VACUUM EQUIPMENT FOR LABORATORY FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rotary, dry-claw vacuum pumps.

1.2 DEFINITIONS

- A. Actual Air: Air delivered at vacuum producer inlet. Flow rate is air measured in acfm.
- B. Laboratory Vacuum Equipment: Vacuum producers and accessories for nonmedical laboratory facilities.
- C. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For vacuum producers.
 - 1. Include plans, elevations, sections, and [mounting]details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Seismic Qualification Certificates: For vacuum producers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For vacuum equipment to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One for each belt-driven vacuum producer.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Laboratory Vacuum Equipment for Nonmedical Laboratory Facilities: An employer of workers trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Vacuum producers[and accessories] shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 GENERAL REQUIREMENTS FOR VACUUM PUMPS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receivers.
- C. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
 - 2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 - 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 - 4. Motor Overload Protection: Overload relay in each phase.
 - 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 - 6. Automatic control switches to [alternate lead-lag vacuum pumps for duplex] [and] [sequence lead-lag vacuum pumps for multiplex] vacuum pumps.
 - 7. Instrumentation: Include vacuum pump inlet and receiver vacuum gages, hour meter, vacuum pump discharge-air and coolant temperature gages, and control transformer.
 - 8. Alarm Signal Devices: For connection to alarm system to indicate when backup vacuum pump is operating.
- D. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols.
 - 1. Interior Finish: Corrosion-resistant coating.
 - 2. Accessories: Include vacuum relief valve, vacuum gage, and drain.
- E. Mounting Frames: Fabricate base and attachment to vacuum pump and components with reinforcement strong enough to resist movement during a seismic event when base is anchored to building structure.

2.3 ROTARY, DRY-CLAW VACUUM PUMPS

- A. Packaged Rotary, Dry-Claw Vacuum System:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Powerex.
 - b. Patton's Medical.
 2. Description: Duplex packaged unit, provided with ASME air receiver, and control panel; pumps shall be factory piped to a common intake manifold, provide vibration isolation pads.
 3. Vacuum Pump(s): Single-stage, rotary, dry-claw type; direct-driven, provided with built-in, anti-suckback valve mounted at pump inlet, check valve, inlet and discharge flex connectors, inlet filter, and pump isolation valve.
 4. Motor: C-face, TEFC, suitable for 460V, 3-phase electrical operation.
 5. Receiver: ASME construction steel tank with vacuum relief valve, internally lined with manual drain and sight gauge.
 6. Control Panel: Automatic lead/lag sequencing and automatic alternation of pumps for equal run time; include gateway server card with PLC controller and touch screen panel, building automation communication gateway with BacNet protocol and Web server features, Ethernet port for connection to BacNet or direct connection to facility, UL508A control panel in NEMA 4 enclosure.
 7. Outlet silencers on discharge connections.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean vacuum equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for laboratory vacuum applications, according to CGA G4.1, "Cleaning Equipment for Oxygen Service."

3.2 VACUUM EQUIPMENT INSTALLATION

- A. Equipment Mounting:
1. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"
- B. Install vacuum equipment anchored to substrate.
- C. Orient equipment so controls and devices are accessible for servicing.
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Install the following devices on vacuum equipment:
1. Thermometer, Vacuum Gage, and Pressure Relief Valve: Install on each vacuum pump receiver.
 2. Drain Valves: Install on receivers. Discharge receiver condensate over nearest floor drain. Discharge separator oral evacuation fluids by direct connection into sanitary waste piping system.

3.3 CONNECTIONS

- A. Comply with requirements for water-supply piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for drain piping specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

- C. Comply with requirements for vacuum piping specified in Section 226213 "Vacuum Piping for Laboratory Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance.
- E. Connect vacuum piping to vacuum equipment, accessories, and specialties with shutoff valve and union or flanged connection.
- F. Connect water supply to vacuum equipment that requires water. Include backflow preventer. Backflow preventers are specified in Section 221119 "Domestic Water Piping Specialties."

3.4 IDENTIFICATION

- A. Identify nonmedical laboratory vacuum equipment system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check for lubricating oil in lubricated-type equipment.
 - 3. Check belt drives for proper tension.
 - 4. Verify that vacuum producer outlet piping is clear.
 - 5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
 - 6. Check safety valves for correct settings.
 - 7. Check for proper seismic restraints.
 - 8. Drain receiver tank(s).
 - 9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 10. Test and adjust controls and safeties.
- B. Verify that vacuum equipment is installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in electrical Sections.
- D. Prepare written report documenting testing procedures and results.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain vacuum producers.

END OF SECTION

SECTION 226600 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Single-wall piping.
 - 2. Piping specialties.

1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.

1.3 PERFORMANCE REQUIREMENTS

- A. Single-Wall Piping Pressure Rating: 10 feet head of water.
- B. Delegated Design: Design seismic restraints for aboveground piping, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For seismic restraints of aboveground piping, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For chemical-waste specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 70, "National Electrical Code."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
- B. Do not store plastic pipe or fittings in direct sunlight.

- C. Protect pipe, fittings, and seals from dirt and damage.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 SINGLE-WALL PIPE AND FITTINGS

- A. CPVC Drainage Pipe and Fittings: ASTM F 2618, pipe and drainage pattern fittings, with Schedule 40 dimensions; with solvent-cement joints.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe.
 - b. Or equal.
- B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.2 JOINING MATERIALS

- A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
- B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
- C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.
- D. Solvent Cement for Joining CPVC Piping: ASTM F 493.
- E. Sampling Ports:

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Chemical-Waste Sewerage Outside the Building:
 - 1. Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground chemical-waste sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
5. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.
6. Install drainage piping pitched down in direction of flow, at minimum slope of 2 percent, unless otherwise indicated.
7. Install drainage piping with 36-inch minimum cover.
8. Install CPVC drainage piping according to ASTM D 231 and ASTM F 1668.
9. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

B. Chemical-Waste Piping Inside the Building:

1. Install piping next to equipment, accessories, and specialties to allow service and maintenance.
2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
3. Flanges may be used on aboveground piping unless otherwise indicated.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Verify final equipment locations for roughing-in.
11. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
12. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 PIPING SPECIALTY INSTALLATION

- A. Embed floor drains in 4-inch minimum depth of concrete around bottom and sides. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for concrete.
- B. Fasten grates to drains if indicated.
- C. Set floor drains with tops flush with pavement surface.
- D. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.
 1. Set cleanout bodies in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade. Set cleanout plugs in concrete pavement with tops flush with pavement surface. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for formwork, reinforcement, and concrete requirements.

3.4 JOINT CONSTRUCTION

- A. Chemical-Waste Sewerage Outside the Building:

1. Plastic-Piping, Solvent-Cement Joints: Make drainage-piping joints according to ASTM F 493.
2. Join dissimilar pipe materials with adapters compatible with pipe materials being joined.

B. Chemical-Waste Piping Inside the Building:

1. Plastic-Piping, Solvent-Cement Joints: Make drainage-piping joints according to ASTM F 493.
2. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe sizes in this article refer to aboveground, single-wall piping.
- B. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- C. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:
1. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- D. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for installation of supports.
- E. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- F. Support vertical piping and tubing at base and at each floor.
- G. Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch.
- H. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 42 inches with 3/8-inch rod.
 2. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6: 48 inches with 3/4-inch rod.
- I. Install supports for vertical CPVC piping every 48 inches.
- J. Support piping and tubing not listed above according to MSS SP-69.

3.6 CONCRETE PLACEMENT

- A. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for concrete supports.
- B. Place cast-in-place concrete according to ACI 318/318R.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make connections to existing piping so finished Work complies as nearly as practical with requirements specified for new Work.
- C. Use commercially manufactured wye fittings for sewerage piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
- D. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.
- E. Install piping adjacent to equipment to allow service and maintenance.

3.8 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.9 FIELD QUALITY CONTROL

- A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place and again at completion of Project.
 - 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Hydrostatic Tests for Drainage Piping:
 - 1) Allowable leakage is a maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
 - 2) Close openings in system and fill with water.
 - 3) Purge air and refill with water.
 - 4) Disconnect water supply.
 - 5) Test and inspect joints for leaks.
 - 2. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Submit separate reports for each test.
- B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

- E. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Chemical-waste piping will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.10 CLEANING

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Clean piping by flushing with potable water.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
- B. Aboveground Chemical-Waste Piping: Use the following piping materials for each size range:
 - 1. NPS 1-1/2 to NPS 6: CPVC drainage piping and solvent-cemented joints.
- C. Under Slab-on-Grade, Indoor, Chemical-Waste Piping: Use the following piping materials for each size range:
 - 1. NPS 1-1/2 to NPS 6: CPVC drainage piping and solvent-cemented joints.

END OF SECTION

SECTION 226700 - PROCESSED WATER PIPING FOR LABORATORY FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes deionized-water piping.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure Ratings:
 - 1. Deionized-Water Piping: 100 psig unless otherwise indicated.
- B. Seismic Performance: Water piping shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For water piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.3, "Process Piping," for piping conveying fluid at a pressure of 15 psig or greater.

PART 2 - PRODUCTS

2.1 PLASTIC PIPE AND FITTINGS

- A. Schedule 40, CPVC Pipe and Fittings: ASTM F 441/F 441M pipe; with plain ends for solvent-cemented joints and ASTM F 438, socket-type fittings.
 - 1. Harvel FlowGuard Gold CTS.
- B. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
 - 1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 TRANSITION FITTINGS

- A. Transition Fittings: Couplings, flanges, or other manufactured fittings; same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 CPVC VALVES

A. CPVC Ball Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. George Fischer LLC.
 - b. NIBCO INC.
2. Description:
 - a. Standards: MSS SP-122 and comply with ASTM F 1970.
 - b. Pressure Rating: 150 psig at 73 deg F.
 - c. Body Material: ASTM D 1784, CPVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D 1784, CPVC compound.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D 1784, CPVC compound.
 - j. Stem Seals: EPDM -rubber O-rings.
 - k. Handle: Tee shaped.

B. CPVC Butterfly Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. George Fischer LLC.
 - b. NIBCO INC.
2. Description:
 - a. Standard: Comply with ASTM F 1970.
 - b. Pressure Rating: 150 psig at 73 deg F.
 - c. Body Material: ASTM D 1784, CPVC compound.
 - d. Body Design: [Lug] [or] [wafer] type.
 - e. Seat: EPDM rubber.
 - f. Disc: ASTM D 1784, CPVC compound.
 - g. Stem: Stainless steel.
 - h. Stem Seals: EPDM -rubber O-rings.
 - i. Handle: Lever type with locking device.

C. CPVC Diaphragm Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. George Fischer LLC.
 - b. NIBCO INC.
2. Description:

- a. Standard: Comply with ASTM F 1970.
- b. Pressure Rating: 150 psig at 73 deg F.
- c. Body Material: ASTM D 1784, CPVC compound.
- d. Body Design: Bolted-bonnet type.
- e. End Connections for NPS 2 and Smaller: Detachable, socket.
- f. End Connections for NPS 2-1/2 and NPS 3: Flanged.
- g. Diaphragm: EPDM rubber.
- h. Seals: EPDM -rubber O-rings.
- i. Handle: Wheel type.
- j. Orion Fittings; a division of Watts Water Technologies Inc.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for removal of ceiling panel, and coordinate with other services occupying that space.
- F. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- G. Install piping to permit valve servicing.
- H. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure ratings unless otherwise indicated.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. CPVC Piping Solvent-Cemented Joints: Comply with ASTM F 402 for handling solvent cements, primers, and cleaners; make joints according to ASTM D 2846/D 2846M Appendix.

- C. Join dissimilar pipe materials with transition fittings compatible with pipe materials being joined.

3.3 VALVE INSTALLATION

- A. Install sectional valves close to mains on each branch and riser serving equipment.
- B. Install shutoff valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves of same size as the pipe or tube in which they are installed unless otherwise indicated.
- E. Install plastic valves of the same material as the plastic pipe in which they are installed.
- F. Install valves in horizontal piping with stem at or above center of pipe.
- G. Install valves in position to allow full movement of stem and lever handle.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Clamps for Vertical Piping: MSS Type 8 or Type 42.
 - 5. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 6. Multiple, Straight, Horizontal Piping Runs, 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 7. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, to minimum 3/8 inch.
- F. Install padded hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
 - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
 - 3. NPS 2-1/2 and NPS 3: 48 inches with 1/2-inch rod.
- G. Install padded supports for vertical CPVC piping NPS 2-1/2 and larger every 120 inches and midstory for NPS 2 and smaller.

- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- C. Connect deionized-water piping to equipment and service outlets with unions or flanges.

3.6 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. Test new piping, and parts of existing piping that have been altered, extended, or repaired, for leaks and defects.
 - 1. Schedule tests and their inspections by authorities having jurisdiction, with at least 24 hours' advance notice.
 - 2. Do not cover piping or put into service before inspection and approval.
 - 3. Test completed piping according to authorities having jurisdiction. If authorities having jurisdiction do not have published procedures, perform tests as follows:
 - a. Hydrostatic Tests: Test piping at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.
 - 1) Exception: Do not subject glass piping to pressure above manufacturer's pressure rating for size.
 - 4. Replace leaking joints with new materials and retest until no leaks exist.
 - 5. Submit separate reports for each test.

3.8 CLEANING

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Before using, purge new piping and parts of existing piping that have been altered, extended, or repaired.
 - 2. Clean piping by flushing with deionized water.

3.9 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping, and of same or compatible material, may be used in applications below.
- B. Deionized-Water Piping: Use the following piping materials for each pipe size range:
 - 1. NPS 3 and Smaller: Schedule 40, CPVC pipe and fittings and solvent-cemented joints.

3.10 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Install ball valves in piping NPS 2 and smaller. Install butterfly or diaphragm valves for NPS 3 piping.
2. Throttling Duty: Install ball valves in piping NPS 2 and smaller. Install diaphragm valves for NPS 3 piping.

END OF SECTION

SECTION 226719 – PROCESSED WATER EQUIPMENT FOR LABORATORY FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Sections Includes:
 - 1. Multimedia filter.
 - 2. Carbon filter.
 - 3. Deionized (DI) mixed beds.
- B. Related Requirements:
 - 1. Section 226700 "Processed Water Piping for Laboratory Facilities" for piping, fittings and valves.

1.2 ACTION SUBMITTALS

- A. Product Data for each type of product, including the following:
 - 1. Equipment dimensions and weight data.
 - 2. Electrical wiring data.
 - 3. Control panel layout.
 - 4. Vibration data.
- B. Shop Drawings:
 - 1. Provide a flow schematic of the proposed system, showing:
 - a. Equipment and accessories.
 - b. Piping and directional flows and sizes.
 - c. Flow rates.
 - d. Connection to domestic water.
 - e. Components.
 - f. Interconnection piping

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS:

- A. Obtain processed water equipment from single source.

2.2 PERFORMANCE REQUIREMENTS

- A. Design equipment based on the make-up water conditions obtained from the city or building water supply quality report.
 - 1. Deionized-Water Piping: 50 psig unless otherwise indicated.
- B. Seismic Performance: Water piping shall withstand the effects of earthquake motions.

2.3 MULTIMEDIA FILTRATION

- A. Multimedia Filtration:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Purtec Industrial Water.
 - b. Or equal.

- B. Filter Tank:
 - 1. Material: Fiberglass with a polyethylene liner and inner shell constructed of HDPE.
 - 2. Rated Working Pressure: 125 psig at 120 deg F temperature.
- C. Distributor Assembly:
 - 1. Single Nonclogging Segmented Distributor:
 - a. For tanks 18 inches in diameter and smaller.
 - b. Material: ABS.
- D. Operating Valves:
 - 1. Fully Automatic Multiport Control Valve:
 - a. Motor-driven single-piston valve with a piston timer to control regeneration program.
 - b. Fully adjustable.
- E. Diaphragm Valves: Permit separate water source for backwashing.

2.4 CARBON FILTER

- A. Carbon Filter:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Puretec Industrial Water.
 - b. Or equal.
- B. Filter Tank:
 - 1. Welded, industrial-grade, cold-rolled carbon steel with dished heads constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels. Tank shall have the maximum working pressure of not less the 125 psig.
 - 2. Filter Media:
 - a. One layer of 3 cu. ft. of activated carbon.
 - 3. The tank shall be provided with O-Ring seals at the openings, inlets, and outlets.
 - 4. Tank shall have an epoxy enamel finish.
 - 5. Provide seven-day time clock to allow the system to regenerate at any time of the day or night and on any day of the week.

2.5 DEIONIZED (DI) MIXED BEDS

- A. Deionized (DI) Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Puretec Industrial Water.
 - b. Or equal.
- B. Tank:
 - 1. Material: Reinforced fiberglass with vinyl ester lining for removing dissolved ionized solids.
 - 2. Minimum Water Resistivity: 1 megohm - cm at 25 deg C.
 - 3. Pressure Ratings: Operating pressure of not less than 125 psig and test pressure not less than 185 psig.
- C. Resin: Suitable for using in mixed-bed deionizer application and for intended application.

2.6 SOURCE QUALITY CONTROL

- A. Manufacturer to perform a factory test of components, piping, and skid assemblies prior to shipment and furnish certification that the testing has been performed and the certification meets specified design requirements.
- B. Manufacturer to provide standards, QA and hydro test protocols with documents provided.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Locations and Arrangements: Drawings and details indicate general location and arrangement of water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install seismic restraints on equipment. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- C. Install equipment in accordance with all codes, standards, and manufacturers recommendations.
- D. Provide documentation that the equipment has been installed in accordance with manufacturers requirements.
- E. Provide a startup of the equipment and a per-check of all associated piping, valves, control devices and control panels.
- F. After completion of the installation, provide up to four hours of instructional time with the Owner's personnel.
- G. Mount equipment and/or skid(s) on concrete pads.
- H. Connect, calibrate, balance, and adjust equipment, devices, and instrumentation to perform functions as specified.

3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of equipment, piping, fittings, and specialties.
- B. Where installing equipment, allow space for service and maintenance.
- C. Connect deionized-water piping to equipment and service outlets with unions or flanges.

3.3 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
- D. Tests and Inspections:
 - 1. After installation, Installer shall test equipment for performance, leaks, and defects.
 - 2. The Installer shall notify the authorities having jurisdiction and engineer, with at least 24 hours' advance notice.
 - 3. Do not cover equipment or put into service before inspection and approval by the authorities having jurisdiction, Owner and engineer.
 - 4. Submit separate reports for each test.
- E. Processed-water system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.5 SANITIZING OF EQUIPMENT SERVING LABORATORIES

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Remove flow indicators and flow-measuring devices before flushing. Replace after cleaning is completed.
 - 2. Clean equipment by pumping at a sufficient velocity and quantity to dislodge sediment or dirt with Minncare and a deionized- water mixture throughout the system.
 - 3. Open all taps until solution is detected, then close taps. Retain solution in the system at least four hours.

3.6 END OF SECTION 226700

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. EC motor line filter requirements: Provide passive filtering components as required to limit total harmonic voltage distortion (THDv) and total harmonic current distortion (THDi) caused by electronically commutated motors (ECM) and/or loads controlled by silicon controlled rectifiers (SCR) to 5% and 20% respectively. The specified THD performance shall be achieved with the attached motor operating throughout its entire speed and load ranges, with the input voltage to the motor controller at the nominal line voltage. The point of measurement for the specified THD performance shall be at the electrical panelboard where the ECM/SCR branch circuit connects to the power distribution system. The manufacturer shall provide additional line conditioning equipment, if necessary, to meet this requirement. Provide wiring diagram documentation indicating installed location of filtration.
- C. Provide a maintenance free, circumferential conductive micro fiber grounding ring installed on the AC motor to discharge shaft currents to ground. Grounding ring shall be AEGIS SGR (Shaft Grounding Ring).
- D. Motors protected by the AEGIS SGR shall be warranted for the term of the manufacturer's motor warranty from induced bearing current damage.
- E. Motors up to 100 HP shall be provided with a shaft grounding ring installed on either the drive end or non-drive end. Motors over 100 HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the shaft grounding ring manufacturer's recommendations.
- F. All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high-frequency ground strap made of flat braided tinned copper with terminations to accommodate motor foot and system ground connection.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.

2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 ELECTRONICALLY COMMUTATED (EC) MOTORS

- A. Description: EC, variable-speed, dc, programmable brushless motor.
- B. Features:
1. Integral controller/inverter operates wound stator and senses rotor position to electronically commutate the stator.
 2. Controller shall control motor speed through a remote 0- to 10-V-dc control signal.
 3. Motor Mounting: Coordinate with driven equipment; suitable for mounting with motor shaft in either horizontal or vertical position.
- C. Performance:
1. Altitude: Suitable for operation at site altitude.
 2. Electrical Characteristics: Suitable for operation with field power source. Coordinate with electrical Installer.
 3. Energy Efficiency: Complying with governing energy codes; 80 percent or higher maintained throughout entire operating range.
 4. Power Factor: 0.9 or higher at full load.
 5. Service Factor: 1.0 or higher.
 6. Speed Control: Variable, zero to 100 percent.
 - a. Synchronous speed rotation with no slip losses.
 - b. Gradual ramp-up to set point upon receiving a start signal.
 - c. Soft speed change ramps.
 - d. Able to overcome reverse rotation without impact.
 - e. Control airflow within 5 percent of set point regardless of static pressure.
 7. Temperature: Suitable for operation in ambient temperature range encountered.
 8. Thermal Protection:
 - a. Automatically breaks electrical power to motor when temperature exceeds a safe value.
 - b. Automatically resets and restores power when temperature returns to normal range.
- D. Bearings: Sealed and permanently lubricated ball bearings.
- E. Enclosure: ODP or TEFC.
- F. Insulation: Class B or Class F.
- G. Rotor: Permanent magnet with near zero rotor losses that operates independent of motor current.
- H. Materials and Construction:
1. Enclosure and Frame: Aluminum, painted steel, or stainless steel.
 2. End Brackets: Cast aluminum..Motor Leads: Pin or screw terminals.

3. Shaft: Steel or stainless steel.
4. Motor Leads: Pin or screw terminals.
5. Nameplates: Manufacturer's standard.
6. Paint: Manufacturer's standard.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Packless expansion joints.
 - 2. Grooved-joint expansion joints.
 - 3. Alignment guides and anchors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 PACKLESS EXPANSION JOINTS

- A. Metal, Compensator Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Hyspan Precision Products, Inc.
 - c. Metraflex Company (The).
 - d. Or equal.
 - 2. Minimum Pressure Rating: 175 psig unless otherwise indicated.
 - 3. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.
 - 4. Joint Axial Movement: 2 inches of compression and 1/2 inch of extension.
 - 5. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.

- a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
 6. Configuration for Steel Piping: Multi-ply, stainless steel bellows; steel-pipe end connections; and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.
- B. Flexible-Hose Packless Expansion Joints:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Flex-Pression.
 - c. Metraflex Company (The).
 - d. Or equal.
 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b.
 5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
 - a. Stainless steel hoses and single-braid, stainless steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 - b.
 6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless steel hoses and single-braid, stainless steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon steel fittings with flanged welded end connections.
 - a. Stainless steel hoses and single-braid, stainless steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - b. Stainless steel hoses and double-braid, stainless steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- C. Metal-Bellows Packless Expansion Joints:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Hyspan Precision Products, Inc.
 - c. Metraflex Company (The).
 - d. Or equal.
 2. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 3. Type: Circular, corrugated bellows with external tie rods.
 4. Minimum Pressure Rating: 175 psig unless otherwise indicated.
 5. Configuration: Single joint class(es), unless otherwise indicated.
 6. Expansion Joints for Copper Tubing: multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.

- b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: threaded.
 - c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.
7. Expansion Joints for Steel Piping: multi-ply stainless steel bellows, steel pipe ends, and carbon steel shroud.
- a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

2.3 GROOVED-JOINT EXPANSION JOINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - 2. Shurjoint; a part of Aalberts Integrated piping Systems.
 - 3. Victaulic Company.
 - 4. Or equal.
- B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: Galvanized, ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- E. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water EPDM rubber gasket suitable for cold and hot water, and bolts and nuts.

2.4 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides: .
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Hyspan Precision Products, Inc.
 - c. Metraflex Company (The).
 - d. Or equal.
 - 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.
- B. Anchor Materials:
- 1. Steel Shapes and Plates: ASTM A36/A36M.
 - 2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
 - 3. Washers: ASTM F844, steel, plain, flat washers.
 - 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated carbon steel.
 - c. Washer and Nut: Zinc-coated carbon steel.
 - 5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A307, zinc-coated carbon stainless steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated carbon steel.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS - GENERAL

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKLESS EXPANSION JOINTS

- A. Install metal-bellows packless expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- B. Install rubber packless expansion joints according to FSA-PSJ-703.

3.3 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

- A. Install grooved-joint expansion joints to grooved-end steel piping.

3.4 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
 - 3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.5 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least **[five]** <Insert number> pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least **[four]** <Insert number> pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least **[four]** <Insert number> pipe fittings, including tee in main.

END OF SECTION 230516

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Grout.
 - 4. Silicone sealants.

- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Sustainable Design Submittals:
 - 1. Product Data: For sealants, indicating VOC content.
 - 2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Information .

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
 - 4. Or Equal

- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, [anti-corrosion coated] [or] [zinc coated], with plain ends and integral welded waterstop collar.

- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
 - 1. Jay R. Smith Mfg. Co.
 - 2. Zurn Industries, LLC.
 - 3. Or Equal

- B. Description: Manufactured,galvanized sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 GROUT

- A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; Dow Corning 758 Silicone Weather Barrier Sealant.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.; [SCS2350] [SSG4000 UltraGlaze] [SSG4000AC UltraGlaze].
 - c. Polymeric Systems, Inc; [PSI-631] [PSI-641].
 - d. Or Equal
 - 2. Sealant shall have a VOC content of 250 g/L or less.
 - 3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - 4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 4 2 inches above finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

3.3

- A.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves.
 2. Exterior Concrete Walls Below Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.

- 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs Above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves .
 - b. Piping NPS 6 and Larger: Steel pipe sleeves .
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with concealed hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type , stamped-steel type with concealed hinge.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type , stamped-steel type with concealed hinge.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type, stamped-steel type with concealed hinge.
 - f. Bare Piping in Equipment Rooms: One-piece, stamped-steel type , stamped-steel type with concealed hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Filled-system thermometers.
 - 2. Liquid-in-glass thermometers.
 - 3. Duct-thermometer mounting brackets.
 - 4. Thermowells.
 - 5. Dial-type pressure gages.
 - 6. Gage attachments.
 - 7. Test plugs.
 - 8. Test-plug kits.
 - 9. Sight flow indicators.
 - 10. Flowmeters.
 - 11. Thermal-energy meters.

- B. Related Requirements:
 - 1.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Trerice, H. O. Co.
 - c. Weiss Instruments, Inc.
 - d. Or Equal
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, cast aluminum 5-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.

6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Pointer: Dark-colored metal.
8. Window: plastic.
9. Ring: Stainless steel.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device]; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus [1] <Insert number> percent of scale range.

B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Terice, H. O. Co.
 - b. Dwyer.
 - c. Or Equal
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
9. Connector: 3/4 inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.
 - a. Terice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. Weksler Glass Thermometer Corp.
 - d. .
3. Standard: ASME B40.200.
4. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
5. Case Form: Adjustable angle unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue[or red] organic liquid.
7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
8. Window: plastic.
9. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.

10. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.4 THERMOWELLS

- A. Thermowells:
1. Standard: ASME B40.200.
 2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
 3. Material for Use with Copper Tubing: CNR.
 4. Material for Use with Steel Piping: CRES.
 5. Type: Stepped shank unless straight or tapered shank is indicated.
 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 8. Bore: Diameter required to match thermometer bulb or stem.
 9. Insertion Length: Length required to match thermometer bulb or stem.
 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 DIAL-TYPE PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Terrice, H. O. Co.
 - c. Watts; a Watts Water Technologies company.
 - d. Weiss Instruments, Inc.
 - e. Weksler Glass Thermometer Corp.
 - f. .
 2. Standard: ASME B40.100.
 3. Case: Liquid-filled and Sealedcast aluminum or drawn steel; 6-inch nominal diameter.
 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi
 8. Pointer: Dark-colored metal.
 9. Window: Glass.
 10. Ring: Metal or Stainless steel
 11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass or stainless-steel pipe with NPS 1/4 or NPS 1/2 [NPS 1/2] pipe threads.

- C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Peterson Equipment Co., Inc.
 2. Trerice, H. O. Co.
 3. Watts; a Watts Water Technologies company.
 4. Weiss Instruments, Inc.
 5. Weksler Glass Thermometer Corp.
- B. Description: Test-station fitting made for insertion in piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: EPDM self-sealing rubber.

2.8 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Peterson Equipment Co., Inc.
 2. Trerice, H. O. Co.
 3. Watts; a Watts Water Technologies company.
 4. Weiss Instruments, Inc.
 - 5.
- B. Furnish **one** test-plug kit(s) containing **two** thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- D. Carrying Case: Metal or plastic, with formed instrument padding.

2.9 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Dwyer Instruments, Inc.
 2. Emerson Process Management; Rosemount Division.
 3. Ernst Flow Industries.
 4. John C. Ernst Co., Inc.
 5. .
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and **ball** indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 150 psig.

- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.10 FLOWMETERS

2.11 FULL BORE MAGNETIC FLOW METERS

- A. Manufacturers
 - 1. Onicon F-3200
 - 2. Siemens/Danfoss Magflo 3100
 - 3. Krohne Optiflux 4000
 - 4. Sparling Tigermag EP FM656
 - 5. Or equal
- B. Description: Flowmeter with sensor, transmitter, and display. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
- C. Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).
- D. Provide a four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube. Output signal shall be a digital pulse proportional to the flow rate (to provide maximum accuracy and to handle abrupt changes in flow). Standard 4-20 mA or 0-10 Vdc outputs may be used on HVAC applications provided accuracy is as specified.
- E. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
- F. Power Source:
 - 1. 24VAC or 24VDC
 - 2. 120V power source not acceptable.
- G. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in gallons per minute (liters per second).
 - 1. Design: Full bore magnetic electrical type flow meter for liquids.
 - 2. Construction: Steel body with ANSI flanges. Lined with:
 - a. Heating hot water: PTFE, PFA, or ETFE liner rated for 210°F minimum fluid temperature
 - b. Chilled, condenser, domestic hot and cold water: Polypropylene, Ebonite PTFE, PFA, or ETFE liner rated for 140°F minimum fluid temperature
 - 3. Minimum Pressure Rating: ANSI class 150 psig (6900 kPa).
 - 4. Minimum Temperature Rating: 158 deg F (260 deg C).
- H. Electrode and grounding material
 - 1. 316L Stainless steel or Hastelloy C
 - 2. Electrodes shall be fused to ceramic liner and not require o-rings.
- I. Electrical Enclosure: NEMA 4 (outdoors), NEMA 1 (indoors)
- J. Approvals
 - 1. UL or CSA

2. NSF Drinking Water approval for domestic water applications
- K. Performance
1. Accuracy shall be $\pm 0.5\%$ of actual reading from 3 to 30 feet per second flow velocities, and ± 0.015 fps from 0.04 fps to 3 fps.
 2. Stability: 0.1% of rate over six months.
 3. Meter repeatability shall be $\pm 0.1\%$ of rate at velocities > 3 feet per second.
- L. Calibration: The sensor must be factory calibrated on an internationally accredited (such as NAMAS) water flow rig with accuracy better than 0.1%. Calibration shall be NIST traceable.
- M. Indicator: Remote display, wall mount with connecting cable.
- N. Transmitter: Must support communication to building control system; see Division 25
- O. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
- P. Operating Instructions: Include complete instructions with each flowmeter.
- Q. Where BTU meter is indicated, flow meter manufacturer shall provide additional accessories required for temperature sensors, transmitter, indicator, and connecting wiring.
1. Temperature sensors shall be insertion type.
 2. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).

2.12 THERMAL-ENERGY METERS

2.13 Thermal Energy Meters

- A. Thermal energy measurement system for integration with full bore magnetic flow meters
1. Manufacturers:
 - a. Onicon SYSTEM-20
 - b. Siemens FEC 920
 - c. Krohne
 - d. Or equal.
 2. Description:
 - a. Total thermal energy measurement (BTU) system to be provided by a single manufacturer, including flowmeter, temperature sensors and BTU meter.
 - b. BTU Calculator: Computation error $\leq 0.09\%$ @ 30-degree F delta T. Calculator to also have the capability to totalize thermal energy flow values.
 - c. Enclosure: NEMA 12K enclosure minimum, designed for wall or DIN rail mounting. Non-metallic enclosure materials of construction must meet UL 94 V-0 flammability requirements and be suitable for use in plenum spaces.
 3. Standards:
 - a. FCC: Part 15, Subpart B
 - b. CE approval
 - c. UL listed
 4. Ratings:
 - a. Pressure: N/A
 - b. Temperature: -13F to 140 F Ambient.
 5. Temperature Sensor Accuracy:

- a. Provide a matched pair of loop lowered, current (mA based temperature sensors, wet calibrated over the intended application range against NIST traceable standards. Current (mA) signal shall be unaffected by wire length.
 - b. Differential temperature measurement uncertainty within calibrated range shall be \leq to ± 0.15 -degree F.
6. Transmitter and Display:
- a. Provide an operator interface with graphical interface which shall be capable of displaying at minimum: instantaneous flow rate, supply temperature, return temperatures, and thermal energy flow rate.
 - b. Meter shall have the capability to receive and totalize three (3) auxiliary input pulses which can be viewed locally and communicated to BMS.
 - c. Must support communication to building control system; see Division 25
7. Calibration and configuration
- a. Each BTU metering system shall be factory programmed for the specific application
- B. Each metering system component, including temperature sensors and flow meters, shall receive a certificate of calibration per N.I.S.T.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending **to center of pipe** and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- I. Install valve and syphon fitting in piping for each pressure gage for steam.
- J. Install test plugs in piping tees.
- K. Install flow indicators in piping systems in accessible positions for easy viewing.
- L. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- M. Install flowmeter elements in accessible positions in piping systems.
- N. Install permanent indicators on walls or brackets in accessible and readable positions.

- O. Install connection fittings in accessible locations for attachment to portable indicators.
- P. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- Q. Install thermometers in the following locations:
 - 1. As noted in details.
- R. Install pressure gages in the following locations:
 - 1. As noted in details.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water and Energy Recovery Piping: 0 to 100 deg F.
- B. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.
- C. .
- D. Scale Range for Air Ducts: 0 to 150 deg F.

3.5 PRESSURE-GAGE SCHEDULE

- A.

3.6 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water and Energy Recovery Piping: 0 to 160 psi.
- B. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Ball valves.
 2. Butterfly valves.
 3. Check valves.
 4. Chainwheels.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene-propylene-diene monomer.
- C. FKM: Fluoroelastomer.
- D. NBR: Nitrile butadiene rubber (also known as "Buna-N").
- E. NRS: Nonrising stem.
- F. OS&Y: Outside screw and yoke.
- G. PTFE: Polytetrafluoroethylene.
- H. RPTFE: Reinforced polytetrafluoroethylene.
- I. RS: Rising stem.
- J. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include material descriptions and dimensions of individual components.
 2. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.
 3. Set ball valves open to minimize exposure of functional surfaces.
 4. Set butterfly valves closed or slightly open.
 5. Block check valves in either closed or open position.
 6. Set gate valves closed to prevent rattling.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for cast-copper solder-joint connections.
 - 6. ASME B16.22 for wrought copper and copper-alloy solder-joint connections.
 - 7. ASME B16.34 for flanged- and threaded-end connections.
 - 8. ASME B16.51 for press joint connections.
 - 9. ASME B31.1 for power piping valves.
 - 10. ASME B31.9 for building services piping valves.
- B. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Bypass and Drain Connections: MSS SP-45.
- G. Valve Actuator Type:
 - 1. Gear Actuator: For quarter-turn ball valves NPS 4 Insert pipe size and larger.
 - 2. Hand Lever: For quarter-turn ball valves smaller than NPS 4 Insert pipe size.
- H. Valves in Insulated Piping:
 - 1. Provide 2-inch extended neck stems.
 - 2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 BALL VALVES

- A. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Red-White Valve Corp.
 - c. WATTS; A Watts Water Technologies Company.

- d. .
 - 2. Standard: MSS SP-110.
 - 3. SWP Rating: 150 psig.
 - 4. CWP Rating: 600 psig.
 - 5. Body Design: Two piece.
 - 6. Body Material: Forged brass.
 - 7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
 - 8. Seats: PTFE.
 - 9. Stem: Brass.
 - 10. Ball: Chrome-plated brass.
 - 11. Port: Full.
- B. Ball Valves, Press Ends - Brass, Two Piece with Full Port and Brass Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Red-White Valve Corp.
 - c. WATTS; A Watts Water Technologies Company.
 - d. .
 - 2. Standards: MSS SP-110 and IAPMO/ANSI Z1157.
 - 3. CWP Rating: 600 psig.
 - 4. Body Design: Two piece.
 - 5. Body Material: Forged brass.
 - 6. Ends: Press.
 - 7. Seats: PTFE or RPTFE.
 - 8. Stem: Brass.
 - 9. Ball: Chrome-plated brass.
 - 10. Port: Full.
 - 11. O-Ring Seal: NBR or EPDM.
- C. Ball Valves, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Crane Fluid Systems; Crane Co.
 - c. Hammond Valve.
 - d. Jenkins Valves; a Crane Co. brand.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Red-White Valve Corp.
 - h. Stockham; a Crane Co. brand.
 - i. WATTS; A Watts Water Technologies Company.
 - j. Zurn Industries, LLC.
 - k. .
 - 2. Standard: MSS SP-110.
 - 3. SWP Rating: 150 psig.
 - 4. CWP Rating: 600 psig.
 - 5. Body Design: Two piece.
 - 6. Body Material: Bronze.
 - 7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
 - 8. Seats: PTFE.
 - 9. Stem: Bronze.
 - 10. Ball: Chrome-plated brass.
 - 11. Port: Full.
- D. Ball Valves, Press Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Center Line; a Crane Co. brand.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Red-White Valve Corp.
 - g. Stockham; a Crane Co. brand.
 - h. Viega LLC.
 - i.
2. Standards: MSS SP-110 and IAPMO/ANSI Z1157.
 3. CWP Rating: Minimum 200 psig.
 4. Body Design: Two piece.
 5. Body Material: Bronze.
 6. Ends: Press.
 7. Press-End Connections Rating: Minimum 200 psig.
 8. Seats: PTFE or RPTFE.
 9. Stem: Bronze or brass.
 10. Ball: Chrome-plated brass.
 11. Port: Full.
 12. O-Ring Seal: EPDM or NBR.
- E. Ball Valves, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Stainless Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Crane Fluid Systems; Crane Co.
 - c. DynaQuip Controls.
 - d. Hammond Valve.
 - e. Jenkins Valves; a Crane Co. brand.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corp.
 - i. Stockham; a Crane Co. brand.
 - j. Viega LLC.
 - k. WATTS; A Watts Water Technologies Company.
 - l. Insert manufacturer's name.
 2. Standard: MSS SP-110.
 3. SWP Rating: 150 psig.
 4. CWP Rating: 600 psig.
 5. Body Design: Two piece.
 6. Body Material: Bronze.
 7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
 8. Seats: PTFE.
 9. Stem: Stainless steel.
 10. Ball: Stainless steel, vented.
 11. Port: Full.
- F. Ball Valves, Threaded Ends - Bronze, Three Piece with Full Port and Bronze or Brass Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. WATTS; A Watts Water Technologies Company.
 - c.
 2. Standard: MSS SP-110.
 3. SWP Rating: 150 psig.
 4. CWP Rating: 600 psig.
 5. Body Design: Three piece.

6. Body Material: Bronze.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Bronze.
10. Ball: Chrome-plated brass.
11. Port: Full.

G. Ball Valves, Threaded Ends - Bronze, Three Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. DynaQuip Controls.
 - c. NIBCO INC.
 - d.
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Three piece.
6. Body Material: Bronze.
7. Ends: Threaded.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

H. Ball Valves, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
 - c. WATTS; A Watts Water Technologies Company
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Regular.

I. Ball Valves, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
 - c. WATTS; A Watts Water Technologies Company.
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Three piece.
6. Body Material: Bronze.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.

11. Port: Regular.
- J. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Stockham; a Crane Co. brand.
 - e. Viega LLC.
 - f. WATTS; A Watts Water Technologies Company.
 - g.
 2. Standard: MSS SP-72.
 3. CWP Rating: 285 psig.
 4. Body Design: Split body.
 5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
 6. Ends: Flanged.
 7. Seats: PTFE.
 8. Stem: Stainless steel.
 9. Ball: Stainless steel, vented.
 10. Port: Full.
- K. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 300:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Stockham; a Crane Co. brand.
 - e. Viega LLC.
 - f. WATTS; A Watts Water Technologies Company.
 - g.
 2. Standard: MSS SP-72.
 3. CWP Rating: 720 psig.
 4. Body Design: Split body.
 5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
 6. Ends: Flanged.
 7. Seats: PTFE.
 8. Stem: Stainless steel.
 9. Ball: Stainless steel, vented.
 10. Port: Full.
- L. Ball Valves, Flanged Ends - Iron, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Sure Flow Equipment Inc.
 - d. WATTS; A Watts Water Technologies Company.
 - e.
 2. Standard: MSS SP-72.
 3. CWP Rating: 200 psig.
 4. Body Design: Split body.
 5. Body Material: ASTM A126, gray iron.
 6. Ends: Flanged.
 7. Seats: PTFE.
 8. Stem: Stainless steel.

9. Ball: Stainless steel.
10. Port: Full.

M. Ball Valves, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c.
 - d. WATTS; A Watts Water Technologies Company.
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. WOG Rating: 1000 psig.
5. Body Design: Split body.
6. Body Material: Type 316 stainless steel.
7. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Type 316 stainless steel.
10. Ball: Type 316 stainless steel.
11. Port: Full.

2.4 BUTTERFLY VALVES

A. Butterfly Valves, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
 - c. Red-White Valve Corp.
 - d. WATTS; A Watts Water Technologies Company.
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[or -coated] ductile iron.

B. Butterfly Valves, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
 - c. Viega LLC.
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

2.5 CHECK VALVES

A. Check Valves, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
 - c. Red-White Valve Corp.
 - d. .
 2. Standard: MSS SP-80, Type 3.
 3. CWP Rating: 200 psig.
 4. Body Design: Horizontal flow.
 5. Body Material: ASTM B62, bronze.
 6. Ends: Threaded.
 7. Disc: Bronze.
- B. Check Valves, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. NIBCO INC.
 - c. Red-White Valve Corp.
 - d. .
 2. Standard: MSS SP-80, Type 3.
 3. CWP Rating: 300 psig.
 4. Body Design: Horizontal flow.
 5. Body Material: ASTM B62, bronze.
 6. Ends: Threaded.
 7. Disc: Bronze.
- C. Check Valves, Swing Type, Press Ends - Bronze:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. .
 2. Standard: MSS SP-80.
 3. CWP Rating: Minimum 200 psig.
 4. Body Design: Horizontal flow.
 5. Body Material: ASTM B584, bronze.
 6. Ends: Press.
 7. Press Ends Connection Rating: Minimum 200 psig.
 8. Disc: Brass or bronze.
- D. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Spring-Closure Control, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Bray International, Inc.
 - c. Clow Valve Company; a subsidiary of McWane, Inc.
 - d. .
 2. Standard: MSS SP-71, Type I.
 3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 psig.
 4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 150 psig.
 5. Body Design: Clear or full waterway.
 6. Body Material: ASTM A126, gray iron with bolted bonnet.
 7. Ends: Flanged.
 8. Trim: Bronze.
 9. Gasket: Asbestos free.

10. Closure Control: Factory-installed, exterior lever and spring.

2.6 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Babbitt Steam Specialty Co.
 2. Roto Hammer Industries; Rotork.
 3. Trumbull Industries.
 4. .
- B. Description:
 1. Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels. Operators shall also be furnished with additional length of lock-link (hot dipped galvanized/spark-resistant brass/stainless steel) chain to allow for operation from finished floor.
 2. Provide a re-useable device that holds chain overhead, clearing the walkway below, is lightweight, has built in drainage, and can easily release chain.
 3. Sprocket Rim with Chain Guides: Ductile iron Ductile or cast iron Cast iron Aluminum Bronze, of type and size required for valve. Include zinc or epoxy coating.
 4. Chain: Hot-dip, galvanized steel Brass Stainless steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Examine press fittings to verify they have been properly pressed.
- F. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Provide support of piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
- D. For valves in horizontal piping, install valves with stem at or above center of pipe.
- E. Install valves in position that does not project into aisles or block access to other equipment.
- F. Install valves in position to allow full stem and actuator or manual operator movement.

- G. Verify that joints of each valve have been properly installed and sealed to ensure that there is no leakage or damage.
- H. Chainwheels: Install chainwheels on manual operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor. Provide baskets to collect chain at a higher elevation.
- I. Install check valves for proper direction of flow and as follows:
 - 1. Check Valves: , in horizontal or vertical position, between flanges.
 - 2. Check Valves, Swing Type: In horizontal position with hinge pin level.
- J. Valve Tags: Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."
- K. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's written recommended maximum.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules.
 - 3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 4. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules.

3.5 CHILLED-WATER AND ENERGY RECOVERY-WATER BALL VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; hreaded or soldered ends.
 - 2. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [threaded] [soldered] ends.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
 - 2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
 - 3. B

3.6 COOLING-COIL CONDENSATE BALL VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:

1. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; threaded or soldered ends.
2. Ball valves, press ends - brass, two piece with full port and brass trim.

3.7 HEATING-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Ball valves, threaded ends - brass, one piece.
2. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; threaded soldered ends.
3. Ball valves, press ends - brass, two piece with full port and brass trim.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; threaded soldered ends.

B. Pipe NPS 2-1/2 and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.

3.8 CHILLED-WATER AND ENERGY RECOVERY WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; 150 CWP, EPDM seat.
2. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; 150 CWP, EPDM seat.

3.9 HEATING-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; 150 CWP, EPDM seat.
2. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; 150 CWP, EPDM seat.

B. Pipe NPS 2-1/2 and Larger:

1. Butterfly valves, single flange (lug type) - high performance, Class 150; stainless steel body.
2. Butterfly valves, single flange (lug type) - high performance, Class 300; stainless steel body.

3.10 CHILLED-WATER AND ENERGY RECOVERY WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.

B. Pipe NPS 2-1/2 and Larger:

1. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; **EPDM**.
2. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; **EPDM**.
3. Check valves, single-plate type - iron, with resilient seat, Class 125; **EPDM** seat.

3.11 HEATING-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Check valves, lift type, threaded ends - bronze, with bronze disc, Class 125.
2. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
3. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.

B. Pipe NPS 2-1/2 and Larger:

1. Check valves, center guided - iron, compact wafer, with resilient seat, Class 125; **EPDM**.
2. Check valves, center guided - iron, compact wafer, with resilient seat, Class 150; **EPDM**.

3. Check valves, single-plate type - iron, with resilient seat, Class 125; **EPDM** seat.
4. Check valves, dual-plate type - iron, with resilient seat, Class 125; **EPDM** seat.
5. Check valves, dual-plate type - iron, with resilient seat, Class 150; **EPDM** seat.

3.12 .

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3.
 - 4. Metal framing systems.
 - 5.
 - 6. Thermal-hanger shield inserts.
 - 7. Fastener systems.
 - 8. Pipe stands.
 - 9. Equipment stands.
 - 10. Equipment supports.

- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
 - 3. Section 233113 "Metal Ducts" for duct hangers and supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.
 - 5. Equipment supports.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. .

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
 3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel stainless steel Insert material.
- B. Stainless Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel Insert material.
- C. Copper Pipe and Tube Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel stainless steel Insert material.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4

2.5 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Haydon Corporation.
 - c. Unistrut; Atkore International.
 - d. Wesanco, Inc.
 - e.
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 4. Channels: Continuous slotted carbon-steel stainless steel, Type 304 stainless steel, Type 316 extruded-aluminum Insert material channel with inturned lips.
 5. Channel Width: Selected for applicable load criteria.
 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel stainless steel Insert material.
 8. Metallic Coating: No coating.
- B. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - b. CADDY; brand of nVent Electrical plc.

- c. Carpenter & Paterson, Inc.
 - d. Empire Industries, Inc.
 - e. Gripple Inc.
 - f. MIRO Industries.
 - g. PHD Manufacturing, Inc.
 - h. RectorSeal HVAC; a CSW Industrials Company.
 - i.
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 4. Channels: Continuous slotted carbon-steel stainless steel Insert material channel with inturned lips.
 5. Channel Width: Select for applicable load criteria.
 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel stainless steel Insert material.
 8. Metallic Coating: No coating.

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Buckaroos, Inc.
 2. CADDY; brand of nVent Electrical plc.
 3. Carpenter & Paterson, Inc.
 4. KB Enterprise.
 5. National Pipe Hanger Corporation.
 6. Pipe Shields Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
 - 10.
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi ASTM C552, Type II cellular glass with 100-psi ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - d.

- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 - f.
 2. Indoor Applications: Zinc-coated stainless steel.
 3. Outdoor Applications: Stainless steel.

2.8 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIRO Industries.
 - b. PHP Systems/Design.
 - c. RectorSeal HVAC; a CSW Industrials Company.
 - d.
 2. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 4. Hardware: Galvanized steel or polycarbonate.
 5. Accessories: Protection pads.
- C. Low-Profile, Single Base, Single-Pipe Stand:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIRO Industries.
 - b. PHP Systems/Design.
 - c.
 2. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
 3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 4. Vertical Members: Two, galvanized- stainless steel, continuous-thread 1/2-inch rods.
 5. Horizontal Member: Adjustable horizontal, galvanized- stainless steel pipe support channels.
 6. Pipe Supports: Roller Strut clamps Clevis hanger Swivel hanger.
 7. Hardware: Galvanized Stainless steel.
 8. Accessories: Protection pads.
 9. Height: 12 inches above roof.
- D. High-Profile, Single Base, Single-Pipe Stand:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIRO Industries.
 - b. PHP Systems/Design.
 - c. Insert manufacturer's name.
2. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
3. Base: Single vulcanized rubber or molded polypropylene.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
4. Vertical Members: Two, galvanized- stainless steel, continuous-thread 1/2-inch rods.
5. Horizontal Member: One, adjustable height, galvanized- stainless steel pipe support slotted channel or plate.
6. Pipe Supports: Roller Clevis hanger Swivel hanger.
7. Hardware: Galvanized Stainless steel.
8. Accessories: Protection pads, 1/2-inch continuous-thread galvanized-steel rod , 1/2-inch continuous-thread stainless steel rod.
9. Height: 36 inches above roof.

E. High-Profile, Multiple-Pipe Stand:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIRO Industries.
 - b. PHP Systems/Design.
 - c. RectorSeal HVAC; a CSW Industrials Company.
 - d.
2. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
3. Bases: Two or more; vulcanized rubber molded polypropylene Insert material.
 - a. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
4. Vertical Members: Two or more, galvanized- stainless steel channels.
5. Horizontal Members: One or more, adjustable height, galvanized- stainless steel pipe support.
6. Pipe Supports: Roller Strut clamps Clevis hanger Swivel hanger.
7. Hardware: Galvanized Stainless steel.
8. Accessories: Protection pads, 1/2-inch continuous-thread rod.
9. Height: 36 inches above roof.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 OUTDOOR EQUIPMENT STANDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. MIRO Industries.
 2. RectorSeal HVAC; a CSW Industrials Company.
 - 3.

- B. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof supported outdoor equipment components, without roof membrane penetration, in a pre-fabricated system that can be modularly-assembled on site.
- C. Foot Material: Rubber or polypropylene.
- D. Rails Material: Hot dip galvanized carbon steel.
- E. Wind/Sliding Load Resistance: Up to 100 mph Insert value minimum.

2.11 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C.

- D. Framing System Installation: Fiberglass. Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
 - 1. Use inserted attachments as the base system. Powder actuated and drilled anchors are only for post concrete changes to the layout.
 - 2. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - 3. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to inches.

3.6 PAINTING

- A. Touchup:
 - 1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
 - 2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- E. Use carbon-steel pipe hangers and supports metal framing systems and attachments for general service applications.
- F. Use stainless steel pipe hangers and stainless steel corrosion-resistant attachments for all exterior supports .
- G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
 - 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Open-spring isolators.
4. Pipe-riser resilient support.
5. Elastomeric hangers.
6. Spring hangers.
7. Snubbers.
8. Restraints - rigid type.
9. Restraints - cable type.
10. Restraint accessories.
11. Concrete inserts.
12. Vibration isolation equipment bases.

B. Related Requirements:

1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.2 DEFINITIONS

A. Designated Seismic System: An HVAC component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.

B. IBC: International Building Code.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-and wind-force-restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Suspended piping:
 - 1. Spring Hangers or Rubber Hangers shall be used for all piping in equipment rooms and up to 50 ft from vibration isolated equipment and pressure regulating valve (PRV) stations.
 - a. The first three hangers from the equipment shall provide the same deflection as the equipment isolators, with a maximum limitation of 2 in. deflection.
 - b. The remaining hangers shall be spring or combination spring and rubber with 0.75 in. deflection.
 - 2. The first two hangers adjacent to the equipment shall be the positioning of precompressed type, to prevent load transfer to equipment flanges when the piping system is filled.
 - 3. Piping over 2 in. in diameter that is suspended below or within 50 ft of noise-sensitive areas shall be hung with combination spring and rubber hangers.
 - 4. Noise-sensitive areas are as follows:
 - a. Conference rooms.
 - b. Class rooms.
 - c. .

2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Isolation Technology, Inc.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 - d. .
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.

5. Surface Pattern: Smooth, ribbed, or waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient.
 - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts: <Insert drawing designation>.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CADDY; a brand of nVent.
 - b. Isolation Technology, Inc.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[with threaded studs or bolts].
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators: .
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Isolation Technology, Inc.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. California Dynamics Corporation.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 3. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.6 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. California Dynamics Corporation.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.7 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. California Dynamics Corporation.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.8 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Vibration Management Corp.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-08 Appendix D for 2009.
 2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
 3. Anchors in Masonry: Design in accordance with TMS 402.
 4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.9 RESTRAINTS - RIGID TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line, an Eaton business.

2. Hilti, Inc.
3. TOLCO.
4. Unistrut; Part of Atkore International.

- B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.10 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line, an Eaton business.
 2. CADDY; a brand of nVent.
 3. Vibration Mountings & Controls, Inc.
- B. Seismic-Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.11 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line, an Eaton business.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. Unistrut; Part of Atkore International.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.12 CONCRETE INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. B-line, an Eaton business.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. Unistrut; Part of Atkore International.

- B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS SP-58.

2.13 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- D. Concrete Inertia Base: [Factory-fabricated] [or] [field-fabricated], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps per details
- B. Hanger-Rod Stiffeners: Install wherever required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present , wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL, WIND-LOAD CONTROL, AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint and wind-load control devices for systems and equipment where where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators, wind-load restraints, must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint, and wind-load-restraint devices using methods that provides required submittals for component.
- G. Install seismic- and wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.
- H. Install seismic-restraint devices using methods that provides required submittals for component.
- I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- L. Mechanical Anchor Bolts:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.5 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.6 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 1. Perform tests and inspections with the assistance of a factory-authorized service representative.
 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 5. Test no fewer than **four** of each type and size of installed anchors and fasteners selected by Architect.

6. Test to 90 percent of rated proof load of device.
 7. Measure isolator restraint clearance.
 8. Measure isolator deflection.
 9. Verify snubber minimum clearances.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Units will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC, PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Equipment labels.
 2. Warning signs and labels.
 3. Pipe labels.
 4. Duct labels.
 5. Valve tags.
 6. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. Brady Corporation.
 - b. Marking Services Inc.
 - c. Seton Identification Products.
 3. Material and Thickness: stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 4. Letter Color: White.
 5. Background Color: Black.
 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 8. Fasteners: Stainless-steel rivets or self-tapping screws.
- B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services Inc.
 - c. Seton Identification Products.
 - d. Or Equal.
 3. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [1/8 inch] thick, and having predrilled holes for attachment hardware.
 4. Letter Color: White.
 5. Background Color: Black.
 6. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 7. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 8. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 9. Fasteners: Stainless-steel rivets or self-tapping screws.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Marking Services Inc.
 3. Seton Identification Products.
- C. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- D. Letter Color: White.
- E. Background Color: Black.
- F. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- G. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- H. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

- I. Fasteners: Stainless-steel rivets or self-tapping screws.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services Inc.
 - 3. Seton Identification Products.
 - 4. Or Equal.
- C. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Marking Services Inc.
 - 3. Seton Identification Products.
 - 4. Or Equal.
- C. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- D. Letter Color: White.
- E. Background Color: Black.
- F. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- G. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- H. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- I. Fasteners: Stainless-steel stainless steel bands, rivets or self-tapping screws.

- J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Marking Services Inc.
 3. Seton Identification Products.
 4. Or Equal.
- C. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch [minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass beaded chain or S-hook].
- D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Marking Services Inc.
 3. Seton Identification Products.
- C. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
 - 1. Chilled-Water and Energy Recovery Water Piping: White letters on a safety-green background.
 - 2. Heating Water Piping: Black letters on a safety-orange background .

3.5 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue : For cold-air supply ducts.
 - 2. Yellow: For hot-air supply ducts.
 - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems: Testing, Adjusting, and Balancing Equipment:
 - a. Constant-flow hydronic systems.
 - b. Condensing units.
 - c. Variable-flow hydronic systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.3 ACTION SUBMITTALS

- A. Sustainable Design Submittals:
 - 1. Air-Balance Report: Documentation indicating that Work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
 - 2. TAB Technician: Employee of the TAB contractor and certified by AABC or NEBB as a TAB technician.
- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
 - 1.
- D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.

- i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
2. Hydronics:
- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning per the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses, close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 2. Verify that the system is under static pressure control.
 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 1. Check liquid level in expansion tank.
 2. Check highest vent for adequate pressure.
 3. Check flow-control valves for proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 5. Verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.
 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
 1. Measure and balance coils by either coil pressure drop or temperature method.
 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Verify final system conditions as follows:
 1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.
- G. Verify that memory stops have been set.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:
 1. Verify that the differential-pressure sensor is located as indicated.
 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
 1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.

- 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 6. Prior to verifying final system conditions, determine the system differential-pressure set point.
 7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 8. Mark final settings and verify that all memory stops have been set.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
 10. Verify that memory stops have been set.
- D. For systems with diversity:
1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.

- 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
- c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
- a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
- a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
- a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
- a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
- a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
13. Verify that memory stops have been set.

3.10 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

- C. Electronically Communicated Motors in Terminal Units: Test for proper operation at airflows ranging from minimum to maximum. Incrementally increase minimum airflow as required until the fan static pressure is within the manufacturers specified range and stable operation is achieved. Record observations including terminal unit tag and final minimum airflow.

3.11 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.
- D. Record liquid and suction conditions on each refrigerant circuit.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.

3.13 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.14 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.15 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves, including pump curves noting pumps piped in parallel.
 2. Fan curves, including fan curves noting fans ducted in parallel.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.

- d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
1. Coil Data:
- a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
- a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.

- m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.

- G. Fan Test Reports: For supply and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.

- H. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

- I. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.

- i. Effective area in sq. ft..
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.

- j. Voltage at each connection.
- k. Amperage for each phase.

L. Instrument Calibration Reports:

- 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.16 VERIFICATION OF TAB REPORT

- A. Architect Owner Construction Manager Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - 1. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- B. Recheck the following measurements in their entirety:
 - 1. Airside:
 - a. All outside air intake flow rates
 - b. All exhaust/relief flow rates
 - c. Supply, return, relief and exhaust airflow rates (as applicable) for all AHUs / RTU/s / DOAUs in the entire project
 - d. 10 percent of all other measurements recorded as randomly selected by the Architect. Submit RFI to the Architect to identify the associated measurements that need to be rechecked.
 - 2. Waterside:
 - a. Pump performance for all pumps, in all hydronic systems in the project.
 - b. Hydronic coil balancing for all coils in AHUs / RTU/s / DOAUs with a minimum design airflow of [5,000] [7,5000] [10,000] CFM, in the entire project.
 - c. 10 percent of all other measurements recorded as randomly selected by the Architect. Submit RFI to the Architect to identify the associated measurements that need to be rechecked.
- C. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- D. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
- E. Prepare test and inspection reports.

3.17 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Outdoor, exposed supply and exhaust.

B. Related Requirements:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program, certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534, Type II for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - d. Or equal
- G. Glass-Fiber Blanket: Glass fibers bonded with a formaldehyde-free thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type II with factory-applied vinyl jacket Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Owens Corning.
 - d. Or equal

- H. Mineral Wool Blanket: Basalt volcanic rock-derived fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C553.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Owens Corning.
 - c. ROCKWOOL Technical Insulation.
 - d. Or equal
- I. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Owens Corning.
 - d. Or equal
- J. Mineral Wool Board: Basalt volcanic rock-derived fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1100 deg F in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Owens Corning.
 - c. ROCKWOOL Technical Insulation.
 - d. Or equal

2.3 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C656, Type II, Grade 6. Tested and certified to provide a 1 -hour fire rating by an NRTL acceptable to authorities having jurisdiction.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. 3M
 - c. Nelson Firestop
 - d. Or equal
- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1 -hour fire rating by an NRTL acceptable to authorities having jurisdiction.
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. 3M.
 - b. Thermal Ceramics.
 - c. Unifrax Corporation.
 - d. Or equal

2.4 ADHESIVES

- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Or equal
 2. Adhesives shall have a VOC content of 50 g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Or equal
 2. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Or equal
 2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS AND COATINGS

- A. Materials are compatible with insulation materials, jackets, and substrates.
1. VOC Content: 300 g/L or less.
 2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Eagle Bridges - Marathon Industries.
 - d. Or equal

2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
 5. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Exterior Use: Suitable for outdoor use on below ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Or equal
 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - d. Or equal
 2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Color: White.

2.6 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Vimasco Corporation.
 - d. Or equal
 2. Adhesives shall have a VOC content of 50 g/L or less.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 4. Service Temperature Range: 0 to plus 180 deg F.
 5. Color: White.

2.7 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Or equal

2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. ASJ Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Or equal
2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White.
6. Sealant shall have a VOC content of 420 g/L or less.

C. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.8 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Or equal
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: Color-code jackets based on system.
- C. Metal Jacket:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 - c. ITW Insulation Systems
 - d. Or equal

2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.
 - d. Or equal
 2. Width: 3.8 inches.
 3. Thickness: 12.6 mils.
 4. Adhesion: 80 ounces force/inch in width.
 5. Elongation: 6.7 percent.
 6. Tensile Strength: 50 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.
 - d. Or equal
 2. Width: 2.5 inches.
 3. Thickness: 6.8 mils.
 4. Adhesion: 70 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 25 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.11 SECUREMENTS

- A. Bands:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems
 - b. RPR Products, Inc.
 - c. Or equal
 2. Stainless Steel: ASTM A240/A240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.
 3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- 0.135-inch- diameter shank, length to suit depth of insulation indicated.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc
 - 4) Or equal
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel aluminum stainless steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc
 - 4) Or equal
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.12 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Section 078413 "Penetration Firestopping."
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Comply with manufacturer's written installation instructions and ASTM C1710.
- B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Square and Rectangular Ducts and Plenums:
1. Provide 1/4 inch more per side for a tight, compression fit.
 2. Cut sheet insulation with the following dimensions:
 - a. Width of duct plus 1/4 inch, one piece.
 - b. Height of duct plus 1/4 inch, plus thickness of insulation, two pieces.
 - c. Width of duct plus 1/4 inch, plus two times the thickness of insulation, one piece.
 3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.
 4. Insulation without self-adhering backing:
 - a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last 1/4 inch where sheets will butt together.
 - b. Roll sheet down into position.
 - c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.
 5. Insulation with self-adhering backing:
 - a. Peel back release paper in 6- to 8-inch increments and line up sheet.
 - b. Press firmly to activate adhesive.
 - c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.
 - d. Allow 1/4-inch overlap for compression at butt joints.

- e. Apply adhesive at the butt joint to seal the two sheets together.
6. Insulate duct brackets following manufacturer's written installation instructions.

D. Circular Ducts:

1. Determine the circumference of the duct, using a strip of insulation the same thickness as to be used.
2. Cut the sheet to the required size.
3. Apply 100 percent coverage of manufacturer adhesive on the metal surface then the insulation.
4. Apply manufacturer adhesive to the cut surfaces along 100 percent of the longitudinal seam. Press together the seam at the ends and then the middle. Close the entire seam starting from the middle.

3.6 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Comply with manufacturer's written installation instructions.
- B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- C. Insulate duct access panels and doors to achieve same fire rating as duct.

- D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

- A. Where field observations by the Owner/Architect/Engineer have determined the insulation systems are in noncompliance, testing shall be required.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 - 1. Non-metal ducts constructed from insulation materials.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums and casings.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round and flat-oval, supply-air duct insulation is one of the following:
 - 1. Mineral-Fiber Blanket
- B. Concealed, rectangular, supply-air duct insulation is one of the following:
 - 1. Minerals-Fiber Blanket
 - 2. Mineral-Fiber Board
- C. Exposed, round and flat-oval, exhaust-air duct insulation is[one of] the following:
 - 1. Minerals-Fiber Blanket
- D. Exposed, rectangular, supply-air duct insulation is[one of] the following:
 - 1. Minerals-Fiber Blanket
 - 2. Mineral-Fiber Board

3.12 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below.
- B. Exposed, rectangular, supply-air duct insulation is[**one of**] the following:
 - 1. Minerals-Fiber Blanket
 - 2. Mineral-Fiber Board

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed: FSK jacket.
- D. Ducts and Plenums, Exposed: aluminum jacket.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Aluminum, Smooth Corrugated: 0.032 inch thick.
- C. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
 - 1. [Painted]Aluminum, Smooth with 1-1/4-Inch- Deep Corrugations : 0.032 inch thick.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating HVAC equipment that is not factory insulated.
- B. Related Sections:
 - 1. Section 230713 "Duct Insulation."
 - 2. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail removable insulation at equipment connections.
 - 2. Detail application of field-applied jackets.
 - 3. Detail application at linkages of control devices.
 - 4. Detail field application for each equipment type.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include, the name of the manufacturer, fabricator, type, description, and size,
- B. Material shall not be stored outside or in a manner that is exposed to the elements. Material stored shall be on dunnage.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

- A. Comply with requirements in "Indoor Equipment Insulation Schedule," and "Outdoor, Aboveground Equipment Insulation Schedule" articles for where insulating materials are applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Owens Corning.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. CertainTeed Corporation; Saint-Gobain North America.
 2. Block Insulation: Type I.
 3. Special-Shaped Insulation: Type III.
 4. Board Insulation: Type IV.
 5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
 6. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type II for sheet materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
- H. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type I, unfaced Type II, with factory-applied vinyl jacket Type III, with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Saint-Gobain North America.

- b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.

- I. Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. Provide insulation unfaced with factory-applied ASJ with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Saint-Gobain North America.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.

- J. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Saint-Gobain North America.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Semirigid board material with factory-applied ASJFSK jacket.
 - 3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 INSULATING CEMENTS

- A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ramco Insulation, Inc.
 - b. Or Equal

- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ramco Insulation, Inc.
 - b. Or Equal

- C. Glass-Fiber and Mineral Wool, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ramco Insulation, Inc.
 - b. Or Equal.

2.4 ADHESIVES

- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - d. Vimasco Corporation.
- C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
 - 3. Wet Flash Point: Below 0 deg F
 - 4. Service Temperature Range: 40 to 200 deg F.
 - 5. Color: Black.
- D. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
- E. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 - e. The Dow Chemical Company.

2.5 MASTICS AND COATINGS

- A. Vapor-Retarder Mastic, Water Based: Suitable for indoor and outdoor use on below-ambient services.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 - 3. Service Temperature Range: 0 to plus 180 deg F minus 20 to plus 180 deg F.
 - 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
 - 5. Color: White.

2.6 LAGGING ADHESIVES

- A. Adhesives comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Vimasco Corporation.
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
 - 3. Service Temperature Range: 20 to plus 180 deg F0 to plus 180 deg F.
 - 4. Color: White.

2.7 SEALANTS

- A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, :
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Owens Corning.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 58 to plus 176 deg FMinus 100 to plus 300 deg F.
 - 4. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
- D. ASJ Flashing Sealants and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: WhiteColor-code jackets based on system. Color as selected by Architect.
 4. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Finish and thickness are indicated in field-applied jacket schedules.
 - b. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper3-mil- thick, heat-bonded polyethylene and kraft paper3-mil- thick polysurlyn.
 - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper3-mil- thick polysurlyn.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 3. Stainless Steel Jacket: ASTM A240/A240M.
 - a. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - b. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper3-mil- thick, heat-bonded polyethylene and kraft paper3-mil- thick polysurlyn.
 - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper3-mil- thick polysurlyn.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. 3M.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
2. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
 3. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
 4. Aluminum Finish: EmbossedSmooth.
- F. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested in accordance with ASTM E96/E96M and with a flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 5 percent.

6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 2. Width: 3 inches.
 3. Film Thickness: 6 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.
 6. Tensile Strength: 55 psi].
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 2. Width: 3 inches.
 3. Film Thickness: 6 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.
 6. Tensile Strength: 55 psi.

2.10 SECUREMENTS

- A. Bands:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 2. Stainless Steel: ASTM A240/A240M, Type 316; 0.015 inch thick, 3/4 inch wide with wing sealorclosed seal.
 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; 0.106-inch-0.135-inch- diameter shank, length to suit depth of insulation indicated.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.

- 2) Gemco.
 - 3) Midwest Fasteners, Inc.
 - 4) Nelson Stud Welding.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; 0.106-inch-0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) CL WARD & Family Inc.
 - 3) Gemco.
 - 4) Midwest Fasteners, Inc.
 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, stainless steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Midwest Fasteners, Inc.
 - 4) Nelson Stud Welding.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, and jackets, of thicknesses required for each item of equipment, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [2 inches][4 inches] o.c.
 - 4. For below-ambient services, apply vapor-barrier mastic over staples.
 - 5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 - 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

- L. Cut insulation in a manner to avoid compressing insulation.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- O. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Glass-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive, anchor pins, and speed washers.
 - 1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for 50percent coverage of tank and vessel surfaces.
 - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - 3. Protect exposed corners with secured corner angles.
 - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints and 16 inches o.c. in both directions.
 - d. Do not compress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins, and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
 - 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
 - 7. Stagger joints between insulation layers at least 3 inches.
 - 8. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 - 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 - 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
 - 1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 - 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
 - 1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.
 - 2. Fabricate boxes from stainless steel, at least 0.050 inch thick.
 - 3. For below-ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.
- B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.
- D. Where PVDC jackets are indicated, install as follows:
 - 1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 - 2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.7 EQUIPMENT INSULATION SCHEDULE, GENERAL

- A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

- B. Acceptable insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials is Contractor's option.
- C. Insulate indoor and outdoor equipment that is not factory insulated.

3.8 OUTDOOR, ABOVEGROUND EQUIPMENT INSULATION SCHEDULE

- A. Energy Recovery Pump :
 - 1. Glass-Fiber Board: 2 inches thick and 3 lb/cu. ft. nominal density.

3.9 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Exposed:
 - 1. Stainless Steel, Type 316, Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulation for HVAC piping systems.
- B. Related Requirements:
 - 1. Section 230713 "Duct Insulation" for duct insulation.
 - 2. Section 230716 "HVAC Equipment Insulation" for equipment insulation.
 - 3. Section 232113.13 "Underground Hydronic Piping" loose-fill pipe insulation in underground piping outside the building.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
 - 3. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program, certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size, as well as ASTM standard designation, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Owens Corning.
 - b. Pittsburgh Corning Corporation
 - c. GLT Products
 - d. Or equal.
 - 2. Preformed Pipe Insulation without Jacket: Type II, Class 1, unfaced.
 - 3. Preformed Pipe Insulation with Jacket: Type II, Class 2, with factory-applied ASJASJ-SSL jacket.
 - 4. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
 - 5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Flexible Elastomeric: Closed-cell, or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I, for tubular materials, Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - d. Or equal.

- H. Mineral Wool, Preformed Pipe: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C547.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation
 - c. Owens Corning.
 - d. Or equal.
 2. Preformed Pipe Insulation: Type II, Grade A with factory-applied ASJ.
 3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.

2.2 INSULATING CEMENTS

- A. Mineral Wool Insulating Cement: Comply with ASTM C195.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ramco Insulation, Inc.
 - b. Or equal.

2.3 ADHESIVES

- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - d. Vimasco Corporation.
 - e. Or equal.
 2. Adhesive: As recommended by calcium silicate manufacturer and with a VOC content of 80 g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Or equal.
 2. Adhesive: As recommended by cellular glass manufacturer and with a VOC content of [80]<Insert value> g/L or less.

3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Flexible Elastomeric Adhesive: Solvent-based adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - d. Or equal.
 2. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of 80 g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - d. Or equal.
 2. Adhesive: As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - d. Or equal.
 2. Adhesives shall have a VOC content of 50 g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 MASTICS AND COATINGS

- A. Materials are compatible with insulation materials, jackets, and substrates.
1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
 2. Mastics shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Knauf Insulation.

- c. Vimasco Corporation.
 - d. Or equal.
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Vimasco Corporation.
 - d. Or equal.
 2. Adhesive shall be as recommended by insulation manufacturer and shall have a VOC content of 50 g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 5. Service Temperature Range: 20 to plus 180 deg F.
 6. Color: White.

2.6 SEALANTS

- A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - d. Owens Corning.
 - e. Or equal.
 2. Permanently flexible, elastomeric sealant.
 3. Sealant shall have a VOC content of 420 g/L or less.
 4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. FSK and Metal Jacket Flashing Sealants:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - d. Or equal.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
 5. Sealant shall have a VOC content of 420 g/L or less.

6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. ASJ Flashing Sealants Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Or equal.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. Sealant shall have a VOC content of 420 g/L or less.
6. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
2. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. ITW Insulation Systems
 - c. RPR Products, Inc.
 - d. Or equal.
2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless Steel Jacket: ASTM A240/A240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Or equal.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Or equal.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following][provide products by one of the following][available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

- a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Or equal.
2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 - c. ITW Insulation Systems
 - d. Or equal.
 2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch 3/4 inch wide with wing seal or closed seal.
 3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch 3/4 inch wide with wing seal or closed seal.
 4. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.
- B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [2 inches][4 inches] o.c.
 - 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes
 5. Handholes
 6. Cleanouts

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using **[prefabricated fitting insulation]****[or]****[mitered or routed fittings]** made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with **[prefabricated fitting insulation]****[or]****[sectional pipe insulation]** of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using **[prefabricated fitting insulation]****[or]****[sectional pipe insulation]** of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using prefabricated fitting insulation or sectional pipe insulation] of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation conforms to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When prefabricated insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install pipe insulation, quads, hex sections, or beveled lag segments, adhered together, of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.7 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 INSTALLATION OF MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation is shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
- B. Chilled Water and Energy Recovery Water and below:
 - 1. NPS 8 and Smaller: Insulation is shall be the following:
 - a. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches thick.
- C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
 - 1. NPS 12 and Smaller: Insulation is shall be the following:
 - a. Mineral Wool, Preformed Pipe, Type II: 2 inches thick.
- D. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation is shall be the following:
 - a. Flexible Elastomeric: 1 inches thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water and Energy Recovery Water :
 - 1. All Pipe Sizes: Insulation is shall be the following:
 - a. Mineral Wool, Preformed Pipe Insulation, Type II: 3 inches thick.
- B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
 - 1. All Pipe Sizes: Insulation is shall be the following:
 - a. Mineral Wool, Preformed Pipe Insulation, Type II: [2 inches]<Insert dimension> thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 2 inches thick.
- D. Heat-Recovery Piping:
 - 1. All Pipe Sizes: Insulation is shall be the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Flexible Elastomeric: 2 inches thick.
 - c. Glass-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

- d. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches thick.
- e.

3.14 OUTDOOR, UNDERGROUND, PIPING INSULATION SCHEDULE

- A. Insulation for belowground piping is specified in Section 232113.13 "Underground Hydronic Piping."
- B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.
- C. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F and Below: Cellular glass, 3 inches thick.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed:
 - 1. Aluminum, SmoothStucco Embossed: 0.020 inch thick.
- C. Piping, Exposed:
 - 1. Aluminum, SmoothStucco Embossed: 0.020 inch thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed:
 - 1. Aluminum, SmoothStucco Embossed: 0.020 inch thick.
- C. Piping, Exposed:
 - 1. Aluminum, SmoothStucco Embossed: [0.016 inch][0.020 inch][0.024 inch][0.032 inch][0.040 inch] thick.

3.17 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes Cx process requirements for the following HVAC systems, assemblies, and equipment:
 - 1. Energy supply systems.
 - 2. Cooling generation systems.
 - 3. Central-station air-handling systems.
 - 4. Air and hydronic distribution systems.
 - 5. Heating and cooling terminal and unitary equipment.
 - 6. BUILDING AUTOMATION SYSTEM (BAS) COMMISSIONING.
 - 7. TAB verification.
- B. Related Requirements:
 - 1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
 - 2. For construction checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

1.2 DEFINITIONS

- A. BAS: Building automation system.
- B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
- C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
- D. CM : Construction Manager.
- E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.
- F. TAB: Testing, adjusting, and balancing.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **[BAS]** **[and]** **[HVAC]** testing technician.
- B. Construction Checklists:
 - 1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Div. 23 Subcontractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.
 - 2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to **[BAS]** **[and]** **[HVAC]** to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements and ASHRAE 202."
- C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Div. 23 Subcontractor, provide the following:
 - 1. Equipment/instrument identification number.

2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:
 - a. Instrument or tool identification number.
 - b. Equipment schedule designation of equipment for which the instrument or tool is required.
 - c. Manufacturer, make, model, and serial number.
 - d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.4 ADDITIONAL RESPONSIBILITIES

- A. Refer to Section 019113: Detailed Contractor responsibilities common to all Divisions are specified in Section 019113. The following are additional responsibilities or notable responsibilities specific to Division 23.
- B. Construction Phase
 1. Provide skilled technicians qualified to perform the work required.
 2. Provide factory-trained and authorized technicians where required by the Contract Documents.
 3. Prepare and submit required draft Start-Up Documentation and submit along with the manufacturer's application, installation and start-up information.
 4. Provide assistance to the CxA in preparation of the specific Functional Performance Test (FPT) procedures. Contractors, subcontractors and vendors shall review FPT procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests. Damage caused to equipment performed in accordance with the approved procedures will be the responsibility of the Contractor.
 5. Thoroughly complete and inspect installation of systems and equipment as detailed throughout Contract Documents, as required by reference or industry standards, and as specifically indicated elsewhere in this Section.
 6. Start-Up, test/adjust/balance, and Turn-Over systems and equipment prior to functional performance testing by the CxA. Approved Start-Up Documentation shall be in accordance with Contract Documents, reference or industry standards, and specifically elsewhere in Part I of this Section.
 7. Record Start-Up on approved Start-Up Documentation forms and certify that the systems and equipment have been started and or tested in accordance with the requirements specified above and in Section 010900. Each task or item shall be indicated with the Party actually performing the task or procedure.
 8. TAB: As outlined in Section 230593. Specifically as it relates to Cx:
 - a. Attend Construction Phase Cx Kick-Off Meeting and Cx progress meetings beginning within 3 months of start of TAB work;
 - b. Submit TAB Plan as indicated above;
 - c. Meet with Cx team to review TAB procedures and documentation required;
 - d. Demonstrate TAB procedures for repetitive tasks (zone balancing, AHU adjusting) as called for by the CxA;
 - e. Participate in Action List dialogue;
 - f. Provide all documentation electronically.
 - g. Attend a meeting convened by the CxA to coordinate with the safety certifying agency. The point of the meeting will be to coordinate protocols and measurement approaches to ensure that devices such as fume hoods and biosafety cabinets will be set up to achieve certification.
 - h. On Canopy Hoods:
 - 1) Calibrate the exhaust terminal airflow measuring station at design flow.
 - 2) Measure and record a 12• grid of hood velocities at the face of the canopy. Ensure the average flow is within 10% of required velocities and that there is not more than 15% variation at the face.

- 3) Use a smoke stick to visualize capture of the source. Report any escapes.
- i. On Fume Hoods:
 - 1) Calibrate the fume hood control airflow measuring device across the range of flow (minimum to stop height).
 - 2) Coordinate with and assist BAC to set up the hood to achieve proper face velocities.
 - 3) Measure and record face velocities in a 12• grid with the sash at specified stop height. If the individual face velocity readings differ by more than 15%, report the deficiency in an Action Item. If the average face velocity is not 100 ft/min (0.51 m/s) +/- 10%, notify BAC and adjust until the face velocity is within tolerance.
 - 4) Retain an independent testing agency to perform the ASHRAE 110 test. Independent agency shall sample 50% of the installed fume hoods. CxA shall select hoods for testing. Manage and coordinate with the independent agency. Schedule the agency late in the Acceptance Period. Report any failures and or deficiencies immediately in an Action Item. Notify Construction Manager and CxA in addition to the party that is assessed as responsible for the deficiency as applicable.

C. Acceptance Phase

1. Assist CxA in Functional Performance Testing. Assistance will typically include the following:
 - a. Manipulate systems and equipment to facilitate Functional Performance Testing
 - b. Provide any specialized instrumentation necessary for Functional Performance Testing;
 - c. Manipulate BAS and other control systems to facilitate Functional Performance Testing.
 - d. Provide a TAB technician to work at the direction of CxA for up to 16 hours beyond assistance specified above.
 - e. Provide a BAS technician to work at the direction of CxA for up to 16 hours beyond assistance specified above.
 - f. Maintain trends and monitor the facility throughout the Endurance Period.

D. Warranty Phase

1. Maintain record documentation of any configurations, setpoints, parameters, etc. that change throughout the Warranty Period.
2. Provide representative for off-season testing as required by CxA.
3. Respond to warranty issues as required by Division 01 and the General Conditions.

1.5 TEMPORARY OPERATION AND CONDITIONING PLAN

- A. Contractor shall be allowed to use permanent building equipment to provide temporary conditioning ONLY upon the approval of the A/E, Owner, and the CxA. Approval for such will only be given upon acceptance of a detailed Temporary Operating and Conditioning Plan provided by the individually involved subcontractors and compiled by the Construction Manager. The Temporary Operating and Conditioning Plan shall consider/address the following at a minimum:
1. Contractor shall address how equipment will be maintained in good, clean condition. Specifically address:
 - a. Temporary Filtering of Air: Air filters used for construction shall be as or more effective than those specified for permanent use. Contractor shall remove construction filters and replace with new filters prior to FPT. Filters shall be maintained and replaced at the specified final pressure drop. Contractor shall install a magnehelic gauge for visual indication of pressure drop as well as setting and adjusting the loaded filter DP switch for monitoring on the BAS.
 - b. Temporary Filtering of Water and Condensate: Construction strainers shall be used while circulating fluid during construction. Construction strainer shall be finer than that specified for final strainers.
 - c. Sealing/Filtering of Open Ducts: Address that all open ducts shall be either sealed or protected with filter media. Return or exhaust systems shall not be used during construction unless otherwise approved.

- d. Lubrication and Maintenance: Contractor shall maintain the systems and equipment in accordance with the manufacturer's instructions. Contractor shall coordinate lubricants used with Owner's operators. Frequency of lubrication and inspection shall be as recommended by manufacturer's literature. Applicable maintenance lubrication schedules shall be included in the Plan. Draft maintenance logs shall be submitted with Plan and completed as maintenance is performed.
 - e. Operation Outside of Normal Ranges: Systems and equipment shall not be operated outside the range of specified conditions. The Temporary Conditioning Plan shall address how the Contractor will ensure that operation will not harm the equipment.
2. Emergency Condition Identification and Response Protocols: The Temporary Conditioning Plan shall address protocols for responding to equipment malfunctions and or harmful operation. Automatic safeties and remote enunciation shall be in place to protect people and property. Temporary operation shall not be allowed until there is an automatic communication/enunciation medium such as a phone connection or an Internet connection. At a minimum, an alarm on the equipment used for temporary service shall be automatically sent to the Contractor's 24 hour monitoring service and to the Owner's help desk. The Contractor shall respond to and be responsible for securing conditions within the building.
 3. Building Protection: Address how the system will be controlled to avoid humidity conditions that could either promote mold growth or cause corrosion.
 4. Equipment Reconditioning: Address with specific means and methods how the equipment used for temporary conditioning will be reconditioned to like-new condition. Belts, seals, bearings, couplings, or other parts that wear more than 3% of their expected life shall be replaced.
 5. Cleaning: Address how ducts, pipes, coils, converters, air handling equipment, terminal units, etc. shall be cleaned prior to Turn-Over.
 6. Operations Log: Contractor responsible for operating the equipment shall maintain a log of all activities associated with operating and maintaining equipment. Log shall be submitted to Owner on a frequency specified by the Owner.
 7. Operating System Alterations: The Temporary Conditioning Plan shall address specific protocol for doing work on the systems.
 8. Damages: Any material, device, component, or equipment that is assessed as damaged or as having a substantially shortened life as a result of temporary conditioning operation shall be replaced by the Contractor at no cost to the Owner or to the project.
 9. Segregation: Where only portions of a system are to be used, Contractor shall specifically indicate how the used portion will be isolated from the unused portion. The Temporary Conditioning Plan shall address how to ensure that the reduced operation condition will be maintained within acceptable ranges, and/or how capacity will be throttled to keep all operating parameters in recommended ranges.

1.6 QUALITY ASSURANCE

- A. BAS Testing Technician Qualifications: Technicians performing BAS Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations are to have the following minimum qualifications:
 1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
 3. International Society of Automation (ISA)-Certified Control Systems Technician (CCST) Level I.
- B. HVAC Testing Technician Qualifications: Technicians to perform HVAC Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:
 1. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.

2. Minimum three years' experience that is to include installing, servicing, and operating systems manufactured by approved manufacturer.
- C. Testing Equipment and Instrumentation Quality and Calibration:
1. Capable of testing and measuring performance within the specified acceptance criteria.
 2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
 3. Be maintained in good repair and operating condition throughout duration of use on Project.
 4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.
- D. Proprietary Test Instrumentation and Tools:
1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
 - a. Be calibrated by manufacturer with current calibration tags permanently affixed.
 - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
 2. HVAC proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Cx PROCESS:

- A. Perform Cx process in accordance with Section 019113 "General Commissioning Requirements" for **[BAS]** **[and]** **[HVAC]** and in accordance with the following:
1. **[ASHRAE 202]**.
 2. **[Commissioning standards acceptable to the authority having jurisdiction]**.

3.2 CONSTRUCTION CHECKLISTS

- A. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each **[BAS]** **[and]** **[HVAC]** system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in ASHRAE 202. Contractor performs the following:
1. Review **[BAS]** **[and]** **[HVAC]** preliminary construction checklists and provide written comments on checklist items where appropriate.
 2. Return preliminary Construction Checklist with review comments within 10 days of receipt.
 3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
 4. Use only construction checklists marked "Approved for Use, (date)" When performing tests. Mark construction checklists in the appropriate place as indicated Project events are completed, and provide pertinent details and other information.
- B. Prepare preliminary detailed construction checklists for each **[BAS]** **[and]** **[HVAC]** system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in ASHRAE 202.
1. Submit preliminary construction checklists to CxA and Designer for review.
 2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."

3. Use only construction checklists, marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed and provide pertinent details and other information.
- C. Additional systems required to be commissioned:
1. Energy supply systems, including the following:
 - a. Central-plant hot-water supply.
 - b. Central-plant chilled-water supply.
 2. Cooling generation systems, including the following:
 - a. Direct-expansion refrigeration systems.
 3. Air-handling systems, including the following:
 - a. Supply, return, and exhaust air fans, motors, and drives.
 - b. Automatic and gravity dampers.
 - c. Heating and cooling devices.
 - d. Air filters.
 - e. Hangers and supports.
 - f. Interlock between air-handling system and fire/smoke alarm system.
 4. Air duct systems, including the following:
 - a. Duct systems.
 - b. Air-duct accessories, including volume dampers, fire and smoke dampers, turning vanes, sound attenuators, and flexible connectors.
 - c. Duct-mounted access doors and panels.
 - d. Hangers and supports.
 5. Hydronic distribution systems, including the following:
 - a. Condensate piping systems, including condensate pumps and all accessories.
 - b. Hydronic piping systems and all accessories.
 - c. Pumps and all accessories.
 - d. Sleeves and sleeve seals.
 - e. Meters and gauges.
 - f. General-duty and specialty valves.
 - g. Hangers and supports
 6. Refrigerant piping, including the following:
 - a. Refrigerant piping, fittings, and specialties.
 - b. Refrigerant charge.
 - c. Sleeves and sleeve seals.
 - d. Meters and gauges.
 - e. General-duty and specialty valves.
 - f. Hangers and supports.
 7. Heating and cooling terminal and unitary equipment, including the following:
 - a. Fan-coil units.
 - b. <Insert units>.
 8. Controls and instrumentation, including the following:
 - a. Energy monitoring and recording system.
 - b. Controllers and sensors.
 - c. Automatic control valves, dampers, and actuators.
 - d. Control interface with fans, pumps, dampers, and other equipment and systems.
 - e. Demand-control systems.
 9. TAB Verification:
 - a. Airflow.
 - b. Water flow.

- c. Space pressurization.
- 10. Documentation:
 - a. Mechanical systems manuals.
 - b. Documentation of required commissioning.
- 11. Mechanical insulation, including the following:
 - a. Duct and plenum insulation.
 - b. HVAC piping insulation.

3.3 Cx TESTING PREPARATION

- A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.
- B. Certify that HVAC instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.
- C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

- A. Perform tests using design conditions, whenever possible.
 - 1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
 - 2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
 - 3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
- C. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

3.5 Cx TESTS COMMON TO HVAC SYSTEMS

- A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.
- B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.
- C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

- D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 23 Sections specifying HVAC systems and equipment.
- E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:
 - 1. Cx Construction Checklist verification tests.
 - 2. Cx Construction Checklist verification test demonstrations.

3.6 CONSTRUCTION CHECKLIST EXAMPLES

- A. Vibration Isolation in HVAC Systems:
 - 1. Prerequisites: Acceptance of results of construction checklists for vibration[**and seismic**] control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment".
 - 2. Components to Be Tested:
 - a. Vibration isolation control devices in HVAC systems.
 - b. Support systems.
 - 3. Test Purpose: Evaluate effectiveness of vibration isolation control devices.
 - 4. Test Conditions, Constant Speed Equipment: Measure vibration of the facility structure at three locations designated by Owner's witness while the isolated equipment operates.
 - 5. Test Conditions, Variable Speed Equipment: Measure vibration of the facility structure at three locations designated by Owner's witness at the following operating conditions:
 - a. Maximum speed.
 - b. Minimum speed.
 - c. Critical speed.
 - 6. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

3.7 TAB VERIFICATION

- A. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
- B. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
- C. Scope: HVAC air systems and hydronic piping systems.
- D. Purpose: Differential flow relationships intended to maintain air and water pressurization differentials between the various areas of Project.
- E. Conditions of the Test:
 - 1. Cx Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
 - 2. Systems operating in full heating mode[**with minimum outside-air volume**].
 - 3. Systems operating in full cooling mode[**with minimum outside-air volume**].
- F. Acceptance Criteria:
 - 1. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
 - 2. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than the tolerances allowed.

3. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.8 AIR-HANDLING SYSTEM Cx TESTS

- A. Test all sequences of operation as shown on the controls drawings.

3.9 BUILDING AUTOMATION SYSTEM (BAS) COMMISSIONING

A. WORK INCLUDED

1. BAS Start-Up and Functional Performance Testing.
2. Validation of proper and thorough installation of BAS and associated equipment.
3. Generic Start-Up Documentation for BAS.
4. Development of final Start-Up Documentation for BAS.
5. Functional Performance Testing of BAS.
6. Coordination of BAS-related training.
7. Documentation of BAS Operation and Maintenance Documentation.

B. GENERAL DESCRIPTION

1. This section defines responsibilities of the Building Automation System Contractor to commission the BAS.
2. Commissioning (Cx) is the process of ensuring that (i) all building systems are installed and perform interactively according to the design intent; (ii) that systems are efficient and cost effective and meet the Owner's operational needs; (iii) that the installation is accurately documented; and (iv) that the Operators are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems, and establishes testing and communication protocols to advance the building systems from installation to optimized, fully-dynamic operation.
3. Commissioning Authority (CxA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Functional Performance Testing.
4. The Commissioning Plan outlines the Cx process beyond the Construction Contract, including design phase activities and design team/owner responsibilities. The specification Sections dictate all requirements of the commissioning process relative to the construction contract. The Cx Plan is not part of the construction contract, although it is available for reference at the request of the Contractor.

C. SCOPE

1. The scope of Commissioning on this project shall include the entire BAS system.

D. DEFINITIONS AND ABBREVIATIONS

1. Refer to Section 019113 for a complete list of Definitions and Abbreviations.
2. POT (Portable Operators Terminal): Portable operator workstation (typically a laptop computer) that has BAS software loaded and the capability to access, program, and edit the BAS.
3. HHD (Hand-Held Device): Portable device (typically with limited functionality) that is used to access components of the BAS. May be a standard PDA or proprietary device/interface.

E. CONTRACTOR RESPONSIBILITIES

1. General responsibilities of the BAS Contractor (BAC) are specified in Section 019113. The following indicate additional specific responsibilities of the BAS Contractor.
2. Assist CxA in verification and Functional Performance Testing. Assistance will typically include the following:
 - a. Establish trend logs of system operation as specified herein.
 - b. Manipulate systems and equipment to facilitate Functional Performance Testing. Typically, this will only be for initial samples of like systems.

- c. Provide POTs or operator workstations in locations convenient to testing activities as specified below.
 - d. Provide CxA with appropriate passwords, keys, and access to control panels and workstations.
 - e. Where control systems do not allow a test mode or the overriding of physical input values for testing, program an interim virtual point for all inputs that can be used to represent the point and be overridden for testing.
3. Provide a control technician to work at the direction of the CxA for software optimization assistance for a minimum of 40 hours during the Acceptance Phase of the project.
 4. Controls Parameter Matrix: Contractor shall provide a form summarizing all setpoints and alarm parameters and alarming strategies for the Owner to complete. Organize a meeting to discuss the desired initial setpoints and alarm parameters. Contractor shall enter the requested setpoints and alarm parameters at completion of start-up and record the applicable settings in the Start-Up Documentation.
 5. Final Systems Operation Training: The BAC shall train the Owner and Operators on whole-building operation and use of the BAS. This training shall focus primarily on BAS control of building systems and operation and its impact on building performance, and shall be conducted after Functional Completion. Additional information is provided in Section 019113.

F. INSTRUMENTATION

1. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
 - a. Temperature sensors and digital thermometers shall have a certified calibration within the past year and a resolution of +/- 0.1°F.
 - b. Pressure sensors shall have an accuracy of +/- 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.
 - c. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed or certificates readily available.
2. Standard Testing Instrumentation: Standard instrumentation used for testing air and water flows, temperatures, humidity, noise levels, amperage, voltage, and pressure differential in air and water systems related to functional testing shall be provided by CxA.
3. Special Tools: Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and turned over to the Owner upon project completion.

G. TAB & COMMISSIONING Portable operators terminal

1. Provide the CxA with all software, connection devices, licenses, passwords, etc. to facilitate connection to the BAS throughout the building. Provide a license to graphic software, and all operating software necessary for testing and configuration of all control elements at all levels. License may be a temporary license that will expire after the completion of the Warranty Period. Options include:
 - a. A laptop computer provided by BAS Contractor for dedicated use by the CxA throughout the Construction and Acceptance Phases. This would be turned over to the Owner at the end of the Acceptance Phase.
 - b. Browser access to the full graphic software: CxA will provide laptop, however BAS Contractor shall set up the laptop to successfully connect.
 - c. Licensed client software to be installed on CxA computer: BAS Contractor shall install the software and ensure it is functional.
 - d. Terminal Services session access to a graphic server with required CALs to allow use of all required software. BAS Contractor shall configure the CxA computer to connect to the terminal session.
2. Access to the BAS must be provided throughout the building as more fully defined as follows:
 - a. Full wireless connection to the graphic server throughout the building will be adequate.

- b. Network connection for full access to the graphic server within 50¢ of any point in the building.
 - c. Exception to 1 and 2 above: An acceptable alternative to full building access to the graphic server relating to terminal controls shall be providing to the CxA the devices and software required to connect to local terminal controllers through a connection port in the space such as connection to a jack on the temperature sensor (basically what is required by TAB specified below). This does not apply to mechanical rooms as full graphic access is required in mechanical rooms.
3. Provide software required by TAB to calibrate all flow sensors. TAB will provide computer to be used as a portable operator's terminal. Any manufacturer specific hardware such as connection cables, converters, hand held devices, etc. shall be provided by the BAS Contractor.
 4. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor as well as at the box. Otherwise a wireless system shall be provided to facilitate this local functionality.

H. BAS Start-Up TESTING, ADJUSTING, CALIBRATION

1. BAS work and/or systems shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this contract, as described below:
 - a. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
 - b. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
 - c. Verify integrity/safety of all electrical connections.
 - d. Coordinate with TAB Contractor to obtain and with CxA to fine tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB Contractor, and note any TAB deficiencies in the BAS Start-Up Documentation:
 - 1) Optimum duct static pressure setpoints for VAV air handling units.
 - 2) Minimum outside air damper settings for air handling units.
 - 3) Optimum differential pressure setpoints for variable speed pumping systems.
 - 4) Calibration parameters for flow control devices such as VAV boxes and flow measuring stations. BAS Contractor shall provide hand held device as a minimum to the TAB and CxA to facilitate calibration. Connection for any given device shall be local to the device (i.e., at the VAV box or at the thermostat). HHD or POT shall allow querying and editing of parameters required for proper calibration and Start-Up.
 - 5) Calibration parameters for fume hoods.
 - e. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start-Up Documentation.
 - f. Check and set zero and span adjustments for all transducers and transmitters.
 - g. For dampers and valves:
 - 1) Check for adequate installation including free travel throughout range and adequate seal.
 - 2) Where control loops are sequenced, check for proper control without overlap
 - h. For actuators:
 - 1) Check to insure that device seals tightly when the appropriate signal is applied to the operator.
 - 2) Check for appropriate fail position, and that the stroke and range is as required and coordinated with the programmed ranges when it is operating under normal conditions.

- 3) For pneumatic operators, adjust the operator spring compression as required to achieve close off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split range positioners to verify proper operation. Record settings for each device.
 - 4) Check the stroke and range under actual loading conditions and validate that they correlate with programmed values.
 - 5) For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
- i. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the OI display. Record the results for each device.
 - j. For outputs to reset other manufacturers devices (such as VSDs) and feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
 - k. Verify proper sequences by using the approved Start-Up Documentation to record results. Verify proper sequence and operation of all specified functions.
 - l. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
 - m. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start-Up Documentation. Except from a start-up, maximum allowable variance from setpoint for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any step-change (for which the system has the capability to respond) in the control loop, the following tolerances shall be maintained (exceptions noted):
 - 1) Duct air temperature: ± 1 deg F
 - 2) Zone temperature: $\pm 3^{\circ}\text{F}$ within 3 minutes and control within ± 2 deg F
 - 3) Chilled water temperatures: ± 1 deg F
 - 4) Hot water temperatures: ± 2 deg F
 - 5) Duct air pressure: ± 0.25 i.w.g
 - 6) Water pressure: ± 1 psig
 - 7) Duct relative humidity: $\pm 3\%$ when adding humidity
 - 8) Zone relative humidity: $\pm 5\%$ when adding humidity
 - 9) Terminal air flow control: $\pm 5\%$ of setpoint. This includes all VAV terminal control and exhausted BSCs, canopy hoods, ventilated cage racks, necropsy tables, and other scientific equipment with supply or exhaust ventilation.
 - 10) Fume hoods: $\pm 10\%$ on full sash travel (from min to max in 3 seconds) within 3 seconds. $\pm 5\%$ when sash is positioned in the controllable range. Refer to Section 15995 for fume hood acceptance requirements.
 - 11) Zone pressurization (on active control systems): ± 0.03 i.w.c. with no door or window movements. No high containment space shall go more than 0.15 i.w.c. positive, nor go positive at all for more than 20 seconds.
 - n. For communication interfaces and BAS control panels:
 - 1) Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
 - 2) Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
 - 3) Check power supplies for proper voltage ranges and loading.
 - 4) Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
 - 5) Check for adequate signal strength and acceptable bandwidth utilization on communication networks.
 - 6) Check for stand-alone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
 - 7) Ensure that all outputs and devices fail to their proper positions/states.
 - 8) Ensure that buffered and/or volatile information is retained through power outage.

- 9) With all system and communications operating normally and all trends functioning, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
 - 10) Check for adequate grounding of all BAS panels and devices.
 - 11) Run self diagnostic routines and ensure they are functional.
 - 12) Check the memory allocation and loading to ensure adequate and excess capacity is available and that it will not affect control functionality.
- o. Coordinate desired initial alarm strategies with Owner's Operators. Set all required alarms and document the initial settings in the Start-Up Documentation.
- p. Coordinate all initial setpoints with Owner's Operators. Ensure those setpoints are active.
- q. For Operator Interfaces:
- 1) Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
 - 2) Output all specified BAS reports for review and approval.
 - 3) Verify that the alarm printing and logging is functional and per requirements.
 - 4) Verify that trend archiving to disk and provide a sample to the CxA for review.
 - 5) Verify alarm enunciation functionality. Time delay from actual occurrence to the time updated or enunciated on the screen. Ensure it is per the specified requirements.
 - 6) Verify that real time and historical trends are accessible and viewable in graph format.
 - 7) Verify that paging/dial out alarm annunciation is functional.
 - 8) Verify the functionality of remote OIs and that a robust connection can be established consistently.
 - 9) Verify that required third party software applications required with the bid are installed and are functional.
 - 10) Demonstrate open protocol and custom third party interfaces reliably communicate and check response time.
 - 11) Verify response times and screen update and refresh times are per the requirements.
 - 12) Verify that all custom programs are editable from the OI. Check upload, download, back up and restore capabilities of system configuration information as well as custom programs.
 - 13) Verify schedules are set up and working.
 - 14) Verify Owner stipulated security and permissions is set up and functional.
 - 15) In concert with the Building Power Outage test, validate that critical GUI installations are properly powered by UPS and emergency outlets to keep it functional during a power outage. Validate that the space has adequate lighting to manage the building in the event of an outage.
- r. Start-up and check out control air compressors and air drying and filtering systems in accordance with the appropriate section and with manufacturer's instructions.
- 1) Validate adequate drying and pressures.
 - 2) Validate adequate redundancy
 - 3) Validate max run time and cycle time vs manufacturer's recommendations
 - 4) Validate that routing of the compressed air does not result in condensation at any point in the system when used with the specified drier.
 - 5) Check all PRVs both primary and back up to ensure adequate functionality and maintenance of downstream pressure.
- s. Verify proper interface with Fire Alarm System.
- t. Verify proper interface with control panels of equipment with self-contained controls that are being monitored by the BAS.
2. Submit Start-Up Documentation. This shall be completed, submitted, and approved prior to demonstration and Acceptance Phase.

I. SENSOR CHECKOUT AND CALIBRATION

1. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.
2. Calibration: Calibrate all sensors using one of the following procedures:
 - a. Sensors Without Transmitters--Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
 - b. Sensors With Transmitters--Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
3. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to Section 230900.

J. LOOP TUNING

1. For all control loops, Contractor shall tune the loops to ensure the fastest stable response without hunting, offset or overshoot with tolerances defined above. Contractor shall introduce upsets to the load when possible to affect response. Otherwise, setpoints can be changed to affect the response.
2. Generally tune loops during periods of high gain.
3. Document all parameters either by capturing text, short interval trends, or screen shots of trend graph documenting the final response.

K. COIL VALVE LEAK CHECK

1. Verify proper close off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via the OI, command the valve to close. Energize fans. After 5 minutes, observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

L. VALVE STROKE SETUP AND CHECK

1. For all valve and actuator positions checked, verify the actual position against the OI readout.
2. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command valve to a few intermediate positions. If actual valve position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

M. GRAPHIC COORDINATION

1. The Contractor shall prepare all graphics (only one example graphic is required for typical systems like terminal units) with points embedded for review of CxA and Owner. Owner shall use these graphics to provide direction to Contractor for the required final graphic. All final graphics must be complete and active before functional testing. Any deviation from the approved graphics will be considered a failure from the perspective of the functional test.

N. BAS DEMONSTRATION

1. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the CxA and Owner. Schedule the demonstration with the Owner's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved.
2. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.
3. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner and CxA.
4. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:
 - a. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
 - b. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
 - c. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.
 - d. Demonstrate correct calibration of input/output devices using the same methods specified for the start-Up tests. A maximum of 10 percent of I/O points shall be selected at random by CxA and/or Owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by CxA for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
 - e. Demonstrate that all BAS and other software programs exist at respective field panels. The BAS programming and point database shall be as submitted and approved.
 - f. Demonstrate that all BAS programs accomplish the specified sequences of operation.
 - g. Demonstrate that the panels automatically recover from power failures, as specified.
 - h. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
 - i. Identify access to equipment selected by CxA. Demonstrate that access is sufficient to perform required maintenance.
 - j. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.
5. BAS Demonstration shall be completed and approved prior to Functional Performance Testing. CxA shall determine if the system is ready for Functional Performance Testing and document any problems requiring Contractor attention.

- a. If the systems are not ready for Functional Performance Testing, Contractor shall correct problems and provide notification to the Owner's representative that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional one week period. This process shall be repeated until CxA issues notice that the BAS is ready for Functional Performance Testing.
6. Any tests successfully completed during the BAS Demonstration will be recorded as "Passed" for the Functional Performance Testing and will not have to be re-accomplished.

O. FUNCTIONAL PERFORMANCE TESTING

1. Requirements for assistance with Functional Performance Testing are specified in the Section 019113, Section 230800 and Section 260800. Provide assistance during Functional Performance Testing per the Section 019113 and related Specifications.

P. BAS ACCEPTANCE PHASE AND OBSERVATION PERIOD

1. BAS Acceptance Phase: BAS Acceptance Phase consists of the Functional Performance Testing process of the BAS by the CxA and shall begin after approval of the BAS Demonstration and prior to issuance of Substantial Completion. Acceptance Phase for the BAS shall not be scheduled until all HVAC systems are in operation, the Start-Up Documentation has been reviewed, all required cleaning and lubrication has been completed (i.e., filters changed, piping flushed, strainers cleaned, etc.), and TAB report has been submitted and approved. Acceptance Phase and its approval to begin will be performed on a system-by-system basis if mutually agreed upon by Contractor and Owner.
2. BAS Observation Period: After Functional Performance Testing, the BAS shall be shown to operate properly for 2 weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. At the end of the two weeks, BAS Contractor shall forward the trend logs to the CxA for review.
3. During the Acceptance Phase, the Contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor's opinion, the cause of the alarm is not the responsibility of the Contractor, Contractor shall immediately notify the Owner's representative.
4. During the Acceptance Phase, the Contractor shall maintain all controller network and workstation hardware and software in a state that will allow remote access by CxA to trend logs as specified below.

Q. BAS TREND REQUIREMENTS

1. The BAS Contractor shall configure and analyze all trends required under this Section.
2. Trends are historical archives on computer disks that document the operation of the systems and equipment. Trends can be time-series (interval) recordings of system I/O parameters or change-of-value (COV) based trends that record when a system value changes by more than a specified threshold.
3. CxA will analyze trend logs of the system operating parameters to evaluate normal system functionality. The requirements of the trending are specified below. Contractor shall establish these trends, ensure they are being stored properly, and forward the data in electronic format to the CxA.
4. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field. Recorded parameters for a given piece of equipment or component shall be trended at the same time intervals and be presented in a maximum of two separate two dimensional formats with time being the vertical axis and field name being the horizontal axis. Data shall be forwarded in one of the following formats.
 - a. Microsoft Access Database (.mdb)
 - b. Microsoft Excel Spreadsheet (.xls)
 - c. Comma Separated Value (.csv or .txt), preferably with quotes delimiting text fields and # delimiting date/time fields.

5. Sample times indicated as COV (\pm) mean that the changed parameter only needs to be recorded whenever the value changes by the amount listed. When output to the trend file, the latest recorded value shall be listed along with the time increment record. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the time interval common to other point trends for the system.
6. Contractor shall provide the CxA with required passwords, phone numbers, etc. to allow the CxA access to the trend log data and allow downloading to a remote location. Contractor shall also provide step-by-step written instructions for accessing the data.
7. Trending Requirements: All I/O points on primary equipment shall be trended throughout the Cx process on 10 min. intervals for analog values and change-of-value for binary values. Trends shall include but are not necessarily limited to the following points:
 - a. Outside air temperature
 - b. Outside air relative humidity
 - c. Outside air enthalpy
 - d. Cooling tons
 - e. All sensed hydronic temperatures
 - f. All sensed air temperatures and relative humidity measurements on primary equipment
 - g. All damper outputs on primary equipment
 - h. All valve outputs on primary equipment
 - i. All sensed fan volumes (flow) on primary equipment
 - j. All inputs and outputs to Variable Speed Drives
 - k. exhaust air temperature on each air handler
 - l. All safety indications
 - m. Status on all primary equipment
 - n. All air and water pressures on primary equipment or systems
 - o. Zone temperatures
 - p. Electricity consumption where monitored.
 - q. All points on primary equipment and selected sampling of terminal points unless approved otherwise.

R. TREND GRAPHS

1. Trend graphs shall be used during Functional Performance Testing to facilitate and document testing. Contractor shall prepare controller and workstation software to display graphical format trends throughout the Acceptance Phase. Trend graphs shall demonstrate compliance with contract documents. Trended values and intervals shall be the same as those specified for the Functional Performance Tests.
2. Lines shall be labeled and shall be distinguishable from each other by using either different line types or different line colors.
3. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.c., Btu/lb, percent wide open, etc.
4. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.
5. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.
6. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended simultaneously and on a common trend period.
7. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.
8. The format of all trend graphs must be provided as approved by the CxA.

S. WARRANTY PHASE - OPPOSITE SEASON TRENDING AND TESTING

1. Trending: Throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Phase. BAS Contractor shall forward archived trend logs to the CxA for review upon CxA request. CxA will review these and notify BAS Contractor of any warranty work required.
2. Opposite Season Testing: Within 6 months of completion of the Acceptance Phase, CxA shall schedule and conduct Opposite Season Functional Performance Testing. The BAS Contractor shall support this testing and remedy any deficiencies identified.

T. SOFTWARE OPTIMIZATION ASSISTANCE

1. The Contractor shall provide the services of a BAS technician as specified above at the project site to be at the disposal of the CxA. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the CxA during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be included with the bid. Requests for assistance shall be for contiguous or non-contiguous 8-hour days, unless otherwise mutually agreed upon by Contractor, CxA, and Owner. The Owner's representative shall notify Contractor 2 days in advance of each day of requested assistance.
2. The BAS technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the BAS technician provided cannot perform every software task requested by the CxA in a timely fashion, Contractor shall provide additional qualified personnel at the project site as requested by the CxA to meet the total specified requirement [**per building**] on-site.

U. BAS OPERATOR TRAINING

1. Provide up to 6 complete sets of User Manuals (hard copy and one electronic copy) to be used for training.
2. BAS Contractor shall submit a Training Plan per the requirements of Div 01 to the CM who will forward it to the A/E and CxA for review.
3. On Site Training: Provide services of BAS Contractor's qualified technical personnel to instruct Owners personnel in operation and maintenance of the BAS. Instruction shall be in classroom setting at the project site for appropriate portions of the training. Training may be in non-contiguous days at the request of the Owner. The Owner's representative shall notify Contractor 1-week in advance of each day of requested training. The Contractor's designated training personnel shall meet with the A/E, CxA and Owner's representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall be as follows:
 - a. Basic Operator Workstation Training:
 - 1) Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.
 - 2) Brief overview of the various parts of the BAS O&M manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and BAS programming documentation.
 - 3) Demonstration of workstation login/logout procedures, password setup, and exception reporting.
 - 4) Demonstration of workstation menu penetration and broad overview of the various workstation features.
 - 5) Overview of systems installed.
 - 6) Present all site-specific naming conventions and points lists, open protocol information, configuration databases, back up sequences, upload/download procedures etc.
 - 7) Overview of scheduling procedures.
 - 8) Overview of alarm features, including how to acknowledge, respond to, and archive alarms, and how to access further information from them.
 - 9) Overview of trend features, including how to set up and view trends.
 - 10) Overview of workstation reporting features and introductory level report generation and scheduling.
 - b. BAS Technician Training:
 - 1) General review of sequence of operation and control logic for the project site, including standalone and fail safe modes of operation
 - 2) Uploading/downloading and backing up controller configuration and application programs

- 3) Review of installed components including all communication devices, controllers, I/O, etc., and how to install/replace, maintain, commission, and diagnose them
 - 4) Introduction to controller programming and overview of the programming application interface
 - 5) Defining trends, generating graphs in real time; archiving trends, accessing historical archive and generating reports from them
 - 6) Introductory network administration
 - 7) Introduction to creating and editing graphics
 - 8) Review of setpoint optimization and fine-tuning concepts
 - 9) OI use and maintenance
 - 10) Web page creation as applicable
- c. System Administrator Training:
- 1) Overview of system architecture including all routers, bridges, repeaters, gateways, communications protocols, servers, controllers etc.
 - 2) Overview of and recommendations for backing up and restoring the system configuration database
 - 3) Server maintenance
 - 4) Security Management: Assigning passwords and rights for various users on the server, workstations and GUI software
- d. Final Systems Operation Training
- 1) The BAS Contractor shall conduct Final Systems Operation Training in accordance with Section 019113.
 - 2) Final Systems Operation Training provides the Owner and Operators a training session on whole-building operation. It shall focus primarily on BAS control of building systems and operation and its impact on building performance. System interactions shall be presented and discussed (such as a combined air handler, chiller, boiler, and terminal unit system), along with a detailed presentation of the sequences of operation and their relationship to the BAS. This training shall be conducted by the BAC with assistance from the CxA, and shall be attended by the Owner, Operators, Contractor, Design Team, and by any other Cx Team members deemed necessary by the CxA or the Owner.
 - 3) The Record BAS Shop Drawings shall be provided as a handout for the training.
 - 4) Scheduling, attendees, and training methods shall be as specified in Section 019113.
- e. Fume Hood Controls Training
- 1) The vendor for the fume hood controls shall present a session to occupant representatives on how the fume hood controls work and how to use the hood monitor.
 - 2) The audience for this session shall be the occupants and their representatives. The setting should be in the field at a functioning fume hood.

END OF SECTION 230800

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment, including but not limited to HVAC systems and components, control components for equipment not supplied with factory-wired controls
- B. Direct-Digital Control (DDC) system description
 - 1. The Controls Contractor shall supply and install a complete Direct Digital Control (DDC) Building Automation System (BAS) as required to accomplish the Sequences of Control for heating, ventilating, air-conditioning and other building-level equipment and systems as described herein.
- C. Furnish all labor, materials, equipment and service necessary for a complete and operational DDC BAS pursuant with this specification and as shown on the associated contract drawings.
- D. Provide all labor, material, equipment and service not specifically referred to in this specification or on associated drawings that are required to fulfill the functional intent of this specification at no additional cost to the Owner.

1.2 DEFINITIONS

- A. B-AAC: Advanced Application Controllers
- B. B-ASC: Application Specific Controllers
- C. ATC: Automatic Temperature Control
- D. BAS: Building Automation System
- E. B-AWS: Advanced Workstation Software
- F. B-OWS: Operator Workstation Software
- G. B-BBC: Building Controllers
- H. BLCN: Building Level Communication Network
- I. BTN: BACnet Testing Laboratories
- J. DDC: Direct digital control.
- K. HLC: Heavy load conditions.
- L. I/O: Input/output.
- M. MS/TP: Master slave/token passing.
- N. PC: Personal computer.
- O. PID: Proportional plus integral plus derivative.
- P. RTD: Resistance temperature detector.

1.3 DDC SYSTEM REQUIREMENTS

- A. DDC Systems installed under this specification shall strictly adhere to the following characteristics:
1. Building Automation System (BAS) Direct Digital Controls (DDC) shall consist of native BACnet, microprocessor-based, peer-to-peer, networked, distributed devices utilizing the BACnet communication protocol in an open, interoperable system. The BAS also includes operator interface devices, programming and configuration software applications, DDC input/output devices, non-DDC automatic temperature controls, enclosures and interconnecting conduit and wire.
 - a. The BACnet operating stack must be embedded directly in every Device at the board level, and in all operator interface software packages.
 - b. No Gateways, Communication Bridges, Protocol Translators or any other device that translates any proprietary or other communication protocol to the BACnet communication protocol shall be permitted as a part of the BAS installation pursuant with this specification section. Gateways may only be used as required for communication to existing systems or systems installed pursuant with other specification sections.
 - c. DDC controllers that are not BACnet compliant shall not be acceptable under this specification and are strictly prohibited.
 2. The BAS shall be modular in nature and comprised of a network of stand-alone DDC devices. The System shall be designed and implemented in such a way that it may be expanded in both capacity and functionality through the addition of DDC Devices, sensors, actuators, etc.
 3. All BAS controllers shall be tested, certified, clearly stamped and listed by the BACnet Testing Laboratories (BTL).
 4. Program database, data acquisition, and all control sequence logic shall reside in each DDC Device. The Building Level Communication Network (BLCN) shall not be dependent upon connection to a Server or Master Controller for performance of the Sequence of Control as outlined in this specification. Each individual Device shall, to the greatest possible extent, perform its programmed sequence without reliance on the BLCN.
 5. All BAS DDC Devices at all levels shall be fully custom-programmable in the field using the standard Operators Workstation Software. No configurable, canned program application specific controllers will be permitted.
 6. All BAS DDC Devices shall be capable of updating firmware using software via internet without replacing any hardware, microprocessors or chips.
 7. The BAS shall be capable of sending system alarms and Event Notifications to pagers, and email services.
 8. Actuation of control devices shall be electronic. Spring return fail-safe actuation shall be provided when loss of property and/or property damage is possible and where specified.
 9. DDC Automatic Temperature Control (ATC) System shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started; along with the time delay between starts shall be user-selectable.
 10. All binary output points shall be protected from short cycling via output configuration and/or programming. This feature shall allow minimum on time and off-time to be configurable.
 11. The DDC System Manufacturer product line selected shall be the most current and complete offering from the manufacturer and shall currently be actively manufactured and supported at the time that this project is bid.
 12. This project shall not be used as a test site. First release and test version hardware, software and firmware shall not be implemented on this project under any circumstances.
 13. DDC System devices and spare components or equivalent shall be readily available for a minimum of five (5) years after the completion and final acceptance of this project.

1.4 BASIC SYSTEM ARCHITECTURE

- A. The DDC BAS as provided and installed under this specification shall be a complete system from a single manufacturer designed for use on intranets and the internet.
- B. The primary BAS components shall include but not be limited to:
1. BACnet Advanced Operator Workstation Software (B-AWS)

2. Remote BACnet Advanced Operator Workstation Software (Remote B-AWS)
 3. Portable Operator Workstation Software (Portable B-OWS)
 4. Building Controllers (B-BC)
 5. Advanced Application Controllers (B-AAC)
 6. Application Specific Controllers (B-ASC)
- C. Enterprise Level Communication Network (ELCN) shall consist of high-speed BACnet/IP Local Area Network (LAN) to host Advanced Operators Workstations (B-AWS), Building Controllers (B-BC), Building Level Communication Networks (BLCN) and Web-Enabled remote connectivity.
- D. Building Level Communication Network (BLCN) shall consist of a BACnet internetwork to host field level DDC Controllers.
- E. B-BCs shall automatically route BACnet communications to all configured available BACnet networks.
- F. B-AWS shall be fully IT-compatible devices that communicate directly on a TCP/IP Local Area Network (LAN).
1. LAN shall be 10/100Mbps TCP/IP with the following minimum requirements:
 - a. Cable: 10 base-T, UTP-8 wire, category 5e or greater
 - b. Minimum throughput: 10Mbps with the ability to increase to 100Mbps
 2. Enterprise Level Communication Network (ELCN) shall provide communication between BBCs, B-OWS, remote B-OWS and Web Server using a B/IP LAN backbone.
 3. B-BCs shall connect directly to the LAN and communicate using B/IP without a TCP/IP Gateway or network server.
 4. Coordinate implementation of the BAS on the Owner's LAN without disruption.
- G. BAS Manufacturer must natively support the following BACnet data links as defined in the ANSI/ASHRAE Standard 135-2008, BACnet:
1. Point-to-Point (PTP)
 2. Master Slave/Token Passing (MS/TP)
 3. Ethernet (ISO 8802-3)
 4. BACnet IP (B/IP)
- H. Special Network Architecture Requirements:
1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to the controller that is controlling air-handling-system air-handling unit(s). Basically, create a DDC system LAN that aligns with the air-handling system being controlled.
- I. Field sensors and control devices shall connect to peer-to-peer, fully programmable B-BC, B-AAC & B-ASC as required to achieve the point monitoring and Sequence of Control as specified herein. All devices are to be monitored by a B-AWS. Final control devices are to be electronic.
- J. Each Mechanical System and/or major piece of Mechanical Equipment shall have one (1) dedicated B-BC controller with sufficient I/O capacity such that it shall be connected to ALL field devices and sensors associated with that system and/or piece of equipment. Distributed control of one (1) single piece of major mechanical equipment shall not be performed by multiple controllers.
- K. All BAS controllers, sensors and devices shall be UL listed.
1. All BAS controllers and interface devices must be UL 916 Listed.

1.5 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:

1. DDC System Speed:
 - a. Response Time of Connected I/O:
 - 1) Update AI point values connected to DDC system every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
 - 2) Update BI point values connected to DDC system every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
 - 3) AO points connected to DDC system to begin to respond to controller output commands within two seconds. Global commands to also comply with this requirement.
 - 4) BO point values connected to DDC system to respond to controller output commands within two seconds. Global commands to also comply with this requirement.
 - b. Display of Connected I/O:
 - 1) Update and display analog point COV connected to DDC system every ten seconds for use by operator.
 - 2) Update and display binary point COV connected to DDC system every ten seconds for use by operator.
 - 3) Update graphic display refresh within 8 seconds.
 - 4) Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
2. Network Bandwidth: Design each network of DDC system to include spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions. Minimum spare bandwidth as follows:
 - a. ELCN Networks: 30 percent.
 - b. BLCN Networks: 30 percent.
3. DDC System Data Storage:
 - a. Include capability to archive not less than 48 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends, and other information indicated.
 - b. Local Storage:
 - 1) Provide server with data storage indicated. Server(s) to use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.
4. DDC Data Access:
 - a. When logged into the system, operator able to also interact with any DDC controllers connected to DDC system as required for functional operation of DDC system.
 - b. Use for application configuration; for archiving, reporting, and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
5. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
6. B-BC, B-AAC, & B-ASC shall be able to execute control loops at a selectable frequency at least 1 time every second. The controller shall scan and update the process value and output generated by this calculation at this same frequency at a minimum.
7. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
8. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
9. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

10. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - l. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - m. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - o. Carbon Monoxide: Plus or minus 5 percent of reading.
 - p. Carbon Dioxide: Plus or minus 50 ppm.
 - q. Nitrogen Dioxide: Plus or minus 50 ppm.
 - r. Electrical: Plus or minus 5 percent of reading.
11. Overall combined system repeatability of sensors, controllers and readout devices for a particular application shall be plus or minus 2% of full scale of the operating range. Repeatability of overall combined system of sensor, controller and readout device in a control loop application will be plus or minus 5% of full scale of the operating range.
12. Long-term electronic drift shall not exceed 0.4% per year.
13. All components provided as part of this system shall operate under ambient environmental conditions of 20F to 104F dry bulb and 10% to 90% relative humidity, noncondensing as a minimum. Sensors and control elements shall operate under the ambient environmental temperature, pressure, humidity, and vibration conditions encountered for the installed location. B-OWS equipment (hardware only), such as CRTs and printers, shall, unless designated otherwise, operate properly under ambient environmental conditions of 45F to 90F and a relative humidity of 10% to 90%.
14. Networked components of the system shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.

B. Energy Dashboard

1. Provide interactive, educational dashboard using a web application to display real-time energy data and building performance metrics in a common area shown on the drawings. Incorporate Owner branding and coordinate content with the Owner and A/E of record. Provide user interface for content management that allows the Owner to update text and photos. Provide one 48 inches wall-mounted commercial-grade monitor and infrared multi-touch overlay with 3-year warranty. Provide 24/7 content scheduler.

1.6 SEQUENCE OF OPERATIONS

- A. See the contract drawings for system sequence of operations for each system to be controlled.

1.7 ACTION SUBMITTALS

- A. Submit in writing and so delineated at the beginning of each submittal, known substitutions and deviations from requirements of Contract Documents. Deviation from Contract Documents must be approved by the Engineer of record prior to submittal.
- B. Sequence of Operations, Controls Diagram, BAS architecture, Bill of Materials, Controls Matrix and Points lists shall be a SEPARATE submittal (under separate cover) from all equipment product data associated with the controls system.

- C. Complete BAS Engineering Design Submittal & Drawings shall be prepared pursuant with the following guidelines:
1. Submittal documentation and drawings shall consistently use the same abbreviations, symbols, nomenclature and identifiers. Each control system element shall be assigned a unique identifier pursuant with the Contract Documents.
 2. Submittal documentation and drawings shall have at the beginning an Index and Design Drawing Legend.
 - a. Index shall list all design drawings and elements including the drawing number, sheet number, drawing title, etc.
 - b. Legend shall show and describe all symbols, abbreviations and acronyms used on the Design Drawings.
- D. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- E. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 3. Wiring Diagrams: Power, signal, and control wiring.
 4. Riser diagram of Building Level Communication Network (BLCN) and Enterprise Level Communication Network (ELCN) shall outline execution and details of all network cabling, BAS & Network Hardware including the following:
 - a. All BAS/DDC Hardware with controller number, unique identifier/tag, location, equipment and service.
 - b. All Network Hardware with unique identifier, location and service.
 - c. Network cabling configuration and execution specification.
 - d. Location of all cabling termination points and End of Line (EOL) terminators.
 - e. Location of all network interface jacks.
 - f. A separate riser diagram shall be provided for each network segment.
 5. Details of control panel faces, including controls, instruments, and labeling.
 6. A schedule of all control dampers. This shall include the unique equipment identifier, unique damper identifier/tag, damper size, pressure drop, blade configuration, orientation and axis of frame, blade rotation, location and selection criteria of actuators, nominal and actual sizes, and manufacturer and model number. The Damper Schedule shall include the AMCA 500-D maximum leakage rate at the operating static-pressure differential.
 7. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 9. Controlled Systems:

- a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
- b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
- c. Written description of sequence of operation including schematic diagram.
- d. Points list.

1.8 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Qualification Data: For Installer and manufacturer.
- C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- D. Field quality-control test reports.

1.9 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Operator's Manual with Manufacturers complete operating instructions.
 2. Programming Manual including:
 - a. Documentation of all project specific Application and DDC programs.
 - b. All necessary system Administrator-Level passwords and/or required access credentials.
 - c. Information required for programming BAS.
 - d. Complete Final Point Schedule including all hardware and software data points and documentation of calibration and configuration values for all Inputs, Outputs, Variables and PID Loops at the conclusion of systems commissioning and functional testing.
 - e. Routine preventative maintenance procedures, corrective diagnostic troubleshooting procedures and calibration processes.
 - f. Final Bill of Material with all installed parts, manufacturers, manufacturers' part numbers and ordering information.
 - g. A schedule of recommended spare parts with part numbers and supplier.
 3. Complete system database as functional at the conclusion of systems commissioning and functional testing including all graphics and images used by and/or created for BAS on electronic format as accepted by Owner.
 4. Maintenance instructions and lists of recommended spare parts for each type of control device.
 5. Interconnection wiring diagrams with identified and numbered system components and devices.
 6. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 7. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 8. Calibration records and list of set points.
- B. Software and Firmware Operational Documentation: Include the following:
 1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens for all major equipment or systems, such as; chilled water plant including all components, typical air handling units, etc.
 5. Software license required by and installed for DDC workstations and control systems.

- C. Project Record Documents. Upon completion of installation and systems commissioning submit record documents for review. As-Built Project Record Documents should include:
 - 1. Project Record Application Engineering Drawings shall include all BAS System Engineering Design Submittal with Drawings updated to reflect actual field conditions, architecture and execution.

1.10 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish a recommended list of materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Two Relays each type.
 - 2. Two Space sensors each type.
 - 3. One Duct sensor each type.
 - 4. One actuator each type.
 - 5. One duct pressure DPT.
 - 6. One transformer each type.
 - 7. One controller each type.
 - 8. One Supervisory controller each type.

1.11 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.

1.12 EXTENDED WARRANTIES

- A. Warrant all DDC controllers to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit's performance specifications for a period of two (2) years at a minimum.
- B. Warrant all carbon dioxide (CO₂) sensing elements to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit's performance specifications for a period of three (3) years at a minimum.
- C. Warrant all relative humidity (RH) sensing elements to be free of defect in material and workmanship under normal operation and expected service as published by the manufacturer in the unit's performance specifications for a period of three (3) years at a minimum.
- D. Warrant all other components of the BAS and installation to be free of defects in workmanship and material under normal expected service and use for a period of two (2) years from the date of final acceptance of the BAS by the Owner.
- E. During the warranty period, provide all labor and materials required to repair or to replace all items or components that fail due to defects in workmanship or manufacture at no charge or reduction in service to the Owner.
- F. Except in the event of property loss or damage, warranty service shall be provided during regular working hours Monday through Friday at no charge unless otherwise explicitly outlined in the Contract Documents. Warranty work outside these periods and associated charges shall be coordinated with Owner.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.14 COORDINATION

- A. Coordinate location of all thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate with all related systems, subcontractors and the associated manufacturers responsible for the system to determine the points that are to be mapped from the third party system to the BAS. At a minimum, provide mapping, alarm configuration, and graphic creation for each system.
- C. Coordinate systems outside of Divisions 23 that have been included as a part of the overall BMS system. Achieve compatibility with systems and equipment that interfaces with the BMS systems. Such systems may include;
 - 1. Plumbing Metering.
 - 2. Plumbing Equipment provided under Division 22.
 - 3. Intrusion Detection.
 - 4. Access Control and Security Systems.
 - 5. Clock Systems.
 - 6. PLC Electronic Detention Monitoring and Control Systems.
 - 7. Addressable-fixture Lighting Controls.
 - 8. Digital, Addressable Fire Alarm System.
 - 9. Electrical Power Monitoring and Control.
 - 10. Panelboards.
 - 11. Motor-Control Centers.
 - 12. Emergency Power Equipment.
 - 13. Conditioned electrical branch circuits for BMS devices.
 - 14. **<Insert other systems to be monitored or controlled.>**

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allerton Controls.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, controlled zone, and control device depicted by point-and-click graphics.
- D. Incorporate other monitored or controlled systems identified in paragraph 1.14.C above.

2.2 BACNET ADVANCED OPERATORS WORKSTATION PLATFORM (B-AWS)

- A. The BACnet Advanced Operator Workstation Platform (B-AWS) provides complete configuration, monitoring, modification and operation of the entire DDC System by advanced building operators and technicians.
- B. Provide as specified herein complete all associated Operating System, Operators Workstation Application Software and Third-Party Software Applications preloaded and configured.
- C. BACnet Advanced Operator Workstation Platform (B-AWS) shall reside on the Enterprise Level Communication Network (ELCN) or the Building Level Communication Network (BLCN) using the BACnet/IP data link as specified in ANSI/ASHRAE Standard 135.
 - 1. Provide one PC-based microcomputer(s) with minimum configuration as follows:
 - a. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 - b. Processor: Intel i5 Quad Core, 3.3 GHz.
 - c. SDRAM: 4GB.
 - d. Graphics: HD Video Card.
 - e. Monitor: 19 inches, LCD color.
 - f. Keyboard: QWERTY, 105 keys in ergonomic shape.
 - g. Hard-Disk Drive: 8TB.
 - h. DVD Read/Write Drive: 16X.
 - i. Mouse: Three button, optical.
 - j. Uninterruptible Power Supply: 2 kVa.
 - k. Operating System: Microsoft Windows 10 with high-speed Internet access.
 - 1) ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 - 2. Application Software:
 - a. I/O capability from operator station.
 - b. System security for each operator via software password and access levels.
 - c. Automatic system diagnostics; monitor system and report failures.
 - d. Database creation and support.
 - e. Automatic and manual database save and restore.
 - f. Dynamic color graphic displays with up to 50 screen displays at once.
 - g. Custom graphics generation and graphics library of HVAC equipment and symbols.
 - h. Alarm processing, messages, and reactions.
 - i. Trend logs retrievable in spreadsheets and database programs.
 - j. Alarm and event processing.
 - k. Object and property status and control.
 - l. Automatic restart of field equipment on restoration of power.
 - m. Data collection, reports, and logs. Include standard reports for the following:
 - 1) Current values of all objects.
 - 2) Current alarm summary.
 - 3) Disabled objects.
 - 4) Alarm lockout objects.
 - 5) Logs.
 - n. Custom report development.
 - o. Utility and weather reports.
 - p. Workstation application editors for controllers and schedules.
 - q. Maintenance management.
 - 3. Custom Application Software:
 - a. English language oriented.
 - b. Full-screen character editor/programming environment.

- c. Allow development of independently executing program modules with debugging/simulation capability.
 - d. Support conditional statements.
 - e. Support floating-point arithmetic with mathematic functions.
 - f. Contains predefined time variables.
- D. Portable BACnet Advanced Operators Workstation (Portable B-AWS): Provide one portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:
1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 2. Processor: Intel i3 Quad Core, 2.4 GHz.
 3. SD Random-Access Memory: 2 GB.
 4. Graphics: HD Video Card. .
 5. Monitor: 15 inches, LCD color.
 6. Keyboard: QWERTY 105 keys in ergonomic shape.
 7. Hard-Disk Drive: 2 TB.
 8. DVD Read/Write Drive: 8X.
 9. Pointing Device: Touch pad or other internal device.
 10. Operating System: Microsoft Windows 10 with high-speed internet access.
- E. Communications and Protocols
1. B-AWS information access for the control system shall utilize the BACnet protocol only for communication to B-BCs, B-AACs, B-ASCs and all other BAS DDC controllers.
 2. B-AWS shall reside on the same LAN as B-BCs. B-AWS shall as a minimum support point-to-point (PTP) and BACnet/IP physical/data link layer protocols.
 3. The B-AWS specified here may, at the Owner's option, be located remote from the BACnet internetwork. Other than the difference in B-AWS communication speed, the system shall be capable of remote operation via BACnet LAN types with no degradation in application performance.
 4. B-AWS Operating System (OS) Software shall be consistent on all B-AWS hardware platforms provided.
 5. B-AWS Application Software shall be provided and licensed to Owner. Provide latest versions of software available.

2.3 CONTROL SYSTEM ADVANCED OPERATORS WORKSTATION (B-AWS) APPLICATION SOFTWARE

- A. BACnet Advanced Operator Workstation Platform (B-AWS) software shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for a B-AWS and shall be certified and listed by the BACnet Testing Laboratories (BTL) as a B-OWS. BTL product listings are available from BACnet international.
- B. System Configuration
1. The workstation shall provide a complete engineering tool for the configuration of the system. This shall allow for future system changes under proper password protection including dynamic creation, deletion and modification of all configuration parameters, programs, graphics, trend logs, alarms, schedules and every BACnet@object used in the installed system.
- C. Security
1. Each operator shall be required to log on to the system with a unique user name and password in order to view, edit, add or delete data.
- D. Operators will be able to perform only those commands available for their respective passwords.
1. System security permissions shall be multi layered and defined for each individual operator to restrict/permit day-to-day operations and system configuration.

- a. A minimum of 10 levels of access shall be supported with a configurable matrix of operator actions allowed for each access level, broken down into at least 200 possible operator actions.
 - b. A minimum of 50 passwords shall be supported at each B-OWS.
 2. An administrator-level operator shall have the ability to configure credentials for all other operators.
 3. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving B-AWS in an unsupervised logged-in state.
 4. Security data shall be stored in an encrypted format.
- E. Alarming and Event Notification
1. B-AWS shall utilize BACnet Alarm Events and Protocol Implementation Conformance Statement (PICS) shall support at a minimum the following BACnet Interoperability Building Blocks (BIBBs):
 - a. Alarm and Event - Acknowledge-A (AE-ACK-A)
 - b. Alarm and Event - Notification-A (AE-N-A)
 - c. Alarm and Event - Alarm Summary View-A (AE-AS-A)
 - d. Alarm and Event - View and Modify-A (AE-VM-A)
 - e. Alarm and Event - View Notifications-A (AE-VN-A)
 2. The workstation shall display and log alarms and events from any BACnet object in the system and shall support operator configuration of the alarm limits, differentials, states and reactions for each object in the system.
 3. B-AWS terminal shall provide audible, visual, and printed means of alarm and event notification.
 4. System shall provide log of notification messages. Complete Alarm log of all system and operator transactions shall be archived to the hard disk of the system B-AWS.
 5. Alarm messages shall be in user-definable text (English) and shall be entered either at the B-AWS terminal or via remote communication.
 6. An alarm summary shall be available to show all alarms whether including but not limited to whether or not they have been acknowledged.
 7. System shall provide ability to prioritize and differentiate communications for at least 20 different levels of alarms.
 8. Alarm messages shall be fully customizable in size, content, behavior and sound.
 9. The operator shall be able to view all system alarms from any location in the internetwork. With the proper credentials, an operator shall be able to acknowledge and clear alarms. Alarm and Event Log shall be configurable per workstation and shall display at a minimum alarm time, received time, state, notification class, priority, message, source, time acknowledged, acknowledged by user and action.
- F. Weekly Annual and Special Event Scheduling
1. B-AWS Software shall utilize BACnet Schedules and PICS shall support at a minimum the following BIBBs:
 - a. Scheduling - Advanced View and Modify-A (SCH-AVM-A)
 2. Provide ability to view and modify the schedule for the calendar week and up to 255 special events in a graphical format. Each calendar day and special event shall provide at least ten time/value entries per day.
 3. Provide the ability for the operator to select scheduling for either binary, analog, or multi-state object values.
 4. Provide the ability for the operator to designate days, date ranges, or repeating date patterns as exception schedules.

5. Provide the capability for the operator to define special or holiday schedules and to link the BACnet schedule to a BACnet calendar, thereby over-riding weekly schedule programming on holidays defined in the BACnet calendar.
6. There shall be a provision with proper password access to manually override each schedule.
7. Provide the capability to designate any exception schedule to be "Executed Once" then automatically cleared.
8. Provide the ability to name each exception schedule with a user defined term to describe each special event.
9. The schedule objects shall reside in each individual device. Workstation or server-based scheduling shall not be acceptable.

G. Trend Log Graphing

1. The B-AWS shall support both the BACnet Trend Log and the BACnet Trend Log Multiple standard objects for defining custom trend logs for any object in the system. This definition shall include interval, length, start time and end time.
 - a. The trend data shall be sampled and stored in each individual BACnet device where the object is stored. The workstation or another field level integration platform shall not be required for storage of custom trend logs.
 - b. All long-term data archival to hard-disk shall be performed by a BTL-Listed BACnet® device dedicated for this service.
2. PICS shall support at a minimum the following BIBBs:
 - a. Trending - View-A (T-V-A)
3. All data points (both hardware and software) system-wide shall be assignable to a historical trending program by gathering configurable historical samples of object data stored in the local controller (B-BC, B-AAC, B-ASC).
4. All trend log information shall be displayable in text and graphic format. All information shall be able to be printed in black & white and color and exported directly to a Microsoft Excel Spreadsheet.
5. The B-AWS shall perform the following at a minimum:
 - a. Be capable of automatically retrieving any trend-log from any device on the network without user-intervention.
 - b. Manage connection to internetwork automatically based upon configurable data acquisition thresholds; retrieving data only when necessary rather than streaming data.
 - c. Shall operate as a Microsoft Windows service.
 - d. Be capable of exporting data directly to Microsoft Excel.
 - e. Not require a separate viewer • but shall seamlessly present all archived data together with real-time data stored in device using the standard B-AWS Trend Log Viewer.

H. Runtime Log Information

1. B-OWS Software shall be capable of displaying Runtime and On/Off Cycle data of all Binary data points (both hardware and software) system-wide.
2. Runtime data shall be sampled and stored in each individual BACnet® device where the object is stored using standard BACnet objects and published properties. The workstation shall not be required for storage of custom runtime logs.
3. At a minimum, the Runtime data shall include:
 - a. Total accumulated active time.
 - b. Total accumulated active transitions and active transitions for the current day.

- c. Timestamp and duration for each change of state for the last 100 transitions.
- I. System Configuration, Set-Up and Definition
 1. Device and network status shall be displayed for any device on the BACnet internetwork. At a minimum the following Device Management BIBBs shall be supported:
 - a. Device Management - Automatic Device Mapping-A (DM-ADM-A).
 - b. Device Management - Automatic Network Mapping-A (DM-ANM-A).
 2. All control strategies and energy management routines shall be stored in the controller and shall allow modification and additions by the operator using the B-AWS software. No strategies or routines shall be stored on the B-AWS platform.
 3. B-AWS Software shall have the capability to back-up and restore the programming and database of any BACnet device on the BACnet internetwork. The B-AWS BTL listing shall support the Device Management - Backup and Restore-A (DM-BR-A) BIBB.
 4. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.
 - J. Graphical User Interface (GUI)
 1. B-AWS Software shall support at a minimum BMP, GIF, TIF, JPG, EMF, PNG, SWF and DIB graphic file formats and allow for the use of custom Flash animation objects and URL hyperlinks in every GUI.
 2. B-AWS Software shall provide a color graphics package to allow the user to generate custom dynamic graphics for graphical representation of system design, building and zone level screens, and system parameters. Graphic images may reside on the B-AWS or server; however, all dynamic data and attributes must reside in the controller.
 - a. A listed set of symbols and graphic slides shall be available to allow operators to select from the graphics table to assist in graphic generation.
 - b. All color graphic displays shall be dynamic with current point data automatically updated from the BACnet internetwork to the B-AWS workstation without operator intervention.
 - c. The operator shall be able to manually adjust all data point values (hardware or software) in the system, adjust values of control loops, and command points to local mode or release points to automatic mode.
 - d. The windowing environment of the B-AWS shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, and/or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 - e. Pre-packaged animations for display of fans, pumps, dampers, etc., and shall allow custom user-created .swf and .gif animations to be used to display objects on graphic displays.
 - K. The BAS shall be provided with fully automatic diagnostic procedures for verification of internetwork communication. In the event of communications failure, the system shall automatically Alarm the condition. B-AWS Software shall be capable of remote annunciation to printer, pager and e-mail.
 - L. Control Summaries, Reports and Logging:
 1. The system shall provide self-documentation reporting to summarize control strategies for any point or any user selected group of points within the Control System.
 2. The B-AWS reporting package shall allow the user to configure the point information display in custom format.
 3. The B-AWS shall enable operator to perform Wild Card data point sorting and searches.
 4. The B-AWS shall perform automated network back-up of runtime databases in all devices on the BACnet network according to operator configurable schedule and storage directory structure.

2.4 BUILDING LEVEL CONTROLLERS (B-BC)

- A. All building level controllers shall comply with the minimum requirements of ANSI/ASHRAE Standard 135 Annex L for a BACnet Building Controllers (B-BCs) and shall be certified and listed by the BACnet testing Laboratories (BTL) as a B-BC.
- B. Furnish B-BC(s) as necessary to control large point count major mechanical equipment, and execution of BAS global strategies, and as noted in the execution portion of this specification.
 - 1. Each Mechanical System and/or major piece of Mechanical Equipment (e.g., Chilled Water, Heating Water, Large AHU, etc.) shall have one (1) dedicated DDC controller with sufficient I/O capacity such that it shall be connected to ALL field devices and sensors associated with that system and/or piece of equipment. Distributed control of one (1) single piece of major mechanical equipment shall not be performed by multiple controllers.
 - 2. Each B-BC shall support local hardware Inputs and Outputs (I/O) by the use of on-board I/O and/or I/O expansion modules.
- C. Building level controllers shall reside on the ELCN or BLCN using the BACnet/IP, BACnet/Ethernet or MS/TP data links as specified in ANSI/ASHRAE Standard 135.
- D. B-BC shall be capable of locally executing global strategies for the BAS based on information from any object in the internetwork. Control Systems that require a higher-level host processor for update, time stamps, global point data, COS transfer, on-line control instruction, or communications control between B-BC panels shall not be acceptable.
- E. BAS shall communicate with all B-AWS, B-BC, B-AAC & B-ASC on a peer-to-peer basis, and shall provide real-time clock functions for scheduling and network-wide time synchronization.
- F. B-BC shall have sufficient memory to support its operating system, database, and programming requirements. Battery/capacitor shall retain static RAM memory and clock functions for a minimum of 72 hours.
 - 1. B-BC operating system, field database, and application programs shall reside in EEPROM.
 - 2. B-BC run-time field database and application programs shall reside in battery backed-up on-board memory of EEPROM.
- G. B-BC shall comply with the following Hardware Configuration:
 - 1. B-BC shall have integral power switch. If the device manufacturer provides no on-board switch then the System Contractor shall provide a separate dedicated transformer and switch within each enclosure for each controller present.
 - 2. B-BC shall provide diagnostic LEDs for power, communications and processor status. The B-BC shall continually check the status of its processor and memory circuits.
 - 3. Controller wiring terminals shall be removable terminal strips for ease of installation and service replacement.
 - 4. All hardware inputs shall be Universal (i.e., binary or analog) configured on hardware and/or in software.
 - a. Inputs shall accept dry-contact, thermistor, 4-20 mA, and 0-5VDC.
 - b. Pulse accumulation shall accommodate a maximum frequency of 40Hz.
 - c. Inputs shall have a minimum 10 Bit A/D conversion resolution.
 - d. 24VAC over-voltage protection
 - e. Status LED indicators for each input
 - 5. All hardware outputs shall be Universal and configured on hardware and/or in software.
 - a. Outputs shall provide configurable modulating voltage signal to industry standard 0-5VDC and 0-10VDC analog control devices and relays.

- b. Outputs shall be capable of sourcing 75mA at 12VDC.
 - c. Outputs shall have a minimum 8 Bit D/A conversion resolution.
 - d. 24VAC over-voltage and short protection
- H. B-BC shall interact with the Control System Application Software in compliance with the following:
- 1. Database programming, configuration and modification shall be accomplished through the B-AWS online with the B-BC. The complete database and application program shall reside in the B-BC. The System Contractor shall configure the software to attain the proper sequence of control and to accomplish all other control system functions indicated in the Contract Documents. Provide a copy of all programming on disc to the Owner.
 - 2. The B-BC shall function in a real-time, multi-tasking networked operating environment; able to display database values, programs, and control loops in real-time while functional and online using the B-AWS. The user shall be able to add, delete, or modify objects on-line as required without taking the B-BC offline. The programming shall provide all the necessary mathematics, logic, utility and control functions necessary to execute the specified sequence of control.
 - 3. All required application programming shall be resident in the B-BC, B-AAC & B-ASC, and not in the B-AWS.
 - 4. B-BC shall manage system-wide alarms by performing distributed, independent alarm analysis and filtering. At no time shall the B-BC panel's ability to report alarms be affected by either operator activity at a B-AWS or local I/O device, or communications with other B-BC on the network.
 - a. B-BCs shall have capability to broadcast alarm conditions automatically across the BLCN or ELCN. Alarm Event notifications shall be sent to off-site computer or serial printer. A minimum of one B-BC per site shall be capable of sending SMTP email messages to an email server for configured alarm conditions.
 - b. Active Alarm Events log shall be stored on the B-BC and may be viewed locally or remotely.
 - c. All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.
 - d. The user shall be able to define the specific system reaction for each point alarm and shall be able to customize reaction and filtering to minimize nuisance reporting. Each B-BC panel shall automatically inhibit the reporting of selected alarms during the standby power modes of operation, loss of power, fire alarm mode, and normal system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
 - e. Alarm reports, messages, and files can be directed to a user-defined list of operator devices, or PCs used for archiving alarm information.
 - 5. B-BC shall perform and manage historical data collection. Minimum sampling time shall be configurable with a minimum sample rate of once per second.
 - a. B-BC panels shall store point history files for all analog and binary inputs and outputs.
 - b. Measured and calculated analog and binary data shall also be assignable to user-definable trends.
 - c. Trend data shall be stored at the stand-alone B-BC panels, and uploaded to hard disk storage automatically at preconfigured intervals when archival is desired.
 - 6. Stand-alone B-BC panels shall automatically accumulate and store runtime hours for binary input and output points.
 - 7. B-BC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
 - 8. B-BC panels shall have the ability to count and/or execute events on a daily, weekly, or monthly basis.
- I. Communication and Protocols

1. The B-BC shall continuously scan the BACnet network and maintain a current database of field data in on board battery/capacitor backed RAM or EEPROM, including alarms, passwords, binding tables, device status, etc. The B-BC shall communicate with BACnet devices on the BLCN using the BACnet physical data link MS/TP at a baud rate of no less than 76.8 Kbps where not limited by third party BACnet devices such as variable frequency drives, utility meters, etc.
2. The B-BC shall provide a communications port for connection of the Portable Operators Terminal using Point-to-Point BACnet physical data link layer protocol or a connection to the network using BACnet/IP.
3. B-BC shall support and be capable of monitoring and controlling a network of communicating remote space sensors. These networked sensors shall occupy input/output hardware points in the B-BC.
4. B-BC shall support at a minimum of two (2) distinct dedicated BACnet/IP (B/IP) data link networks using TCP/IP and one (1) BACnet/Ethernet data link network simultaneously.
5. Building level controllers shall support the following communications requirements at a minimum:
 - a. Client and Server BACnet Subscribe Change of Value (COV) Service.
 - b. Client and Server BACnet Read Property Multiple (RPM) Service.
 - c. BACnet@transmit and receive frame segmentation.
 - d. Post-installation, field-configurable maximum information frames, APDU frame timeout, APDU segment timeout and APDU retries.
6. Building level controllers shall support SMTP and provide stand-alone remote annunciation of alarms via e-mail without additional hardware, B-AWS or web-server.

2.5 ADVANCED APPLICATION CONTROLLERS (B-AAC)

- A. B-AAC shall comply with all aforementioned BAS System Requirements and shall comply with or exceed the BACnet profile for Advanced Application Controllers (B-AAC).
- B. Furnish one dedicated B-AAC(s) for each small or medium sized mechanical system.
- C. Each B-AAC shall acquire, process, and store point input data on a real time basis for internal use and for sharing with other controllers. Each B-AAC shall also maintain and supervise digital and analog output signals to the control devices and have a real time operating system capable of time of day scheduling and other time based functions.
 1. If the hardware point requirements of any medium-sized system should exceed the I/O configuration of available B-AAC offerings then a B-BC must be used. Control of one piece of mechanical equipment may not be performed by more than one controller.
- D. B-AAC shall provide microprocessor based self-contained stand-alone fully programmable operation of local process control loops. All local level application programs shall be installed on individual controllers in non-volatile memory.
- E. Each B-AAC shall be capable of sharing point information with other B-BC, B-AAC, or B-ASC on a peer-to-peer basis via the BACnet BLCN.
- F. Control systems that utilize canned programs or programmable read only memory (PROM) level application programming are not acceptable.
- G. Once downloaded, a B-AAC shall not require further communication with the B-AWS except for data base changes, operator commands, and requests from the B-AWS for B-AAC data. Programming of B-AACs shall be completely modifiable in the field, over the installed BACnet network.
- H. Each B-AAC shall be provided with the ability to prevent unauthorized access to its software program.

- I. B-AAC shall have sufficient memory to support its operating system, database, and programming requirements.
 - 1. B-AAC operating system, field database, and application programs shall reside in EEPROM.
- J. B-AAC run-time field database and application programs shall reside in on-board memory or EEPROM.
- K. B-AAC shall feature real-time 24-hour clock and 365-day calendar. Battery or capacitor back-up of these functions is required where the B-AAC is installed as a standalone controller.
- L. B-AAC shall feature a software configurable audible enunciator which shall be configured to trigger on the occurrence of selected alarms, and shall be audible and acknowledgeable either to all users, or only to those users with sufficient password authority.
- M. B-AAC shall comply with the following Hardware Configuration:
 - 1. B-AAC shall provide diagnostic LEDs for power, communications and processor status. The B-AAC shall continually check the status of its processor and memory circuits.
 - 2. Universal field device hardware inputs shall be provided and configured on hardware and/or in software and comply with the following:
 - a. Inputs shall accept dry-contact, thermistor, 4-20 mA, and 0-5VDC
 - b. Pulse accumulation shall accommodate a maximum frequency of 100Hz
 - c. Inputs shall have a minimum 10 Bit A/D conversion resolution
 - d. 24VAC over-voltage protection
 - 3. Hardware Outputs shall be configured as to be modular in nature.
 - 4. Universal hardware outputs shall be provided and configured on hardware or in software and comply with the following:
 - a. Universal Outputs shall provide configurable modulating voltage signal to industry standard 0-5VDC and 0-10VDC analog control devices and relays.
 - b. Outputs shall be capable of sourcing 75mA at 12VDC and 24VDC.
 - c. Outputs shall have a minimum 8 Bit D/A conversion resolution.
 - d. 24VAC over-voltage and short protection.
- N. Control System Application Software:
 - 1. The B-AAC application software shall be the same as and indistinguishable from the B-BC specified interaction with the Control System Application Software.
 - 2. The controller software shall reside in a real time, multi-tasking, networking operating environment. Database definition shall be accomplished through the B-AWS online with the B-AAC. The complete database and application program shall reside in the B-AAC. Configure the software to attain the proper sequence of control and to accomplish all other control system functions indicated in the Contract Documents.
 - 3. The user shall be able to add, delete, or modify objects on-line as required. The programming shall provide all the necessary mathematics, logic, utility and control functions necessary for proper sequence of control.
- O. Communications and Protocols
 - 1. The B-AAC shall communicate with field devices and controllers on the BLCN using the BACnet physical data link MS/TP at 76.8 Kbps where not limited by third party devices such as variable frequency drives, utility meters, etc.
 - 2. The B-AAC shall provide a communications port for connection of the Portable Operators Terminal using Point-to-Point BACnet physical data link layer protocol or a connection to the network.

3. B-AAC shall support and be capable of monitoring and controlling a network of a minimum of four (4) communicating remote space sensors. These networked sensors shall not consume input/output hardware points in the B-AAC.
- P. B-AAC shall perform and manage historical data collection. Minimum sampling time shall be configurable with a minimum sample rate of once per second.
 1. B-AAC panels shall store point history files for all analog and binary inputs and outputs.
 2. Measured and calculated analog and binary data shall also be assignable to user-definable trends.
 3. Trend data shall be stored at the stand-alone B-AAC panels, and uploaded to hard disk storage automatically at preconfigured intervals when archival is desired.
- Q. Stand-alone B-AAC panels shall automatically accumulate and store runtime hours for binary input and output points.
- R. B-AAC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
- S. B-AAC panels shall have the ability to count and/or execute events on a daily, weekly, or monthly basis.
- T. B-AAC shall support, transmit, and receive of segmented messages.

2.6 APPLICATION SPECIFIC CONTROLLERS (B-ASC)

- A. B-ASC shall comply with all aforementioned BAS System Requirements and shall comply with the BACnet profile for Application Specific Controllers (B-ASC).
- B. B-ASC shall reside on the FLCN using the BACnet MS/TP data link as specified in ANSI/ASHRAE Standard 135 in compliance with the following requirements at a minimum:
 1. Automatically detect the baud of the MS/TP network and then configure the device's communication baud to match that of the MS/TP network.
- C. B-ASC shall support the following communications requirements at a minimum:
 1. Client and Server BACnet Subscribe Change of Value (COV) Service.
 2. Client and Server BACnet Read Property Multiple (RPM) Service.
 3. BACnet transmit and receive frame segmentation.
 4. Post-installation, field-configurable maximum information frames, APDU frame timeout, APDU segment timeout and APDU retries.
- D. Provide one dedicated B-ASC for each Terminal Unit Mechanical Device on the project. Those include Variable Air Volume (VAV) Air Terminal Units (ATU), Serial and Parallel Fan-Powered (FP) VAV ATU's, Unit Heaters (UH), Unit Ventilators (UV), Fan Coil Units (FCU) and Individual Fans.
- E. B-ASC shall provide microprocessor based self-contained stand-alone fully programmable operation of local process control loops. All local level application programs shall be installed on individual controllers in non-volatile memory.
- F. Each B-ASC shall be capable of sharing point information with other B-BC, B-AAC, or B-ASC on a peer-to-peer basis via the BACnet BLCN.
- G. Control systems that utilize canned programs or programmable read only memory (PROM) level application programming are not acceptable.

- H. Once downloaded, a B-ASC shall not require further communication with the B-AWS except for data base changes, operator commands, and requests from the B-AWS for B-ASC data. Programming of B-ASCs shall be completely modifiable in the field, over installed BACnet Internetwork.
 - 1. Each B-ASC shall be provided with the ability to prevent unauthorized access to its software program.
 - 2. B-ASC shall have sufficient memory to support its operating system, database, and programming requirements.
 - 3. B-ASC operating system, field database, and application programs shall reside in EEPROM.
 - 4. B-ASC run-time field database and application programs shall reside in on-board non-volatile memory or EEPROM.

- I. B-ASC shall perform and manage historical data collection. Minimum sampling time shall be configurable with a minimum sample rate of once per second.
 - 1. B-ASC panels shall store point history files for all analog and binary inputs and outputs.
 - 2. Measured and calculated analog and binary data shall also be assignable to user-definable trends.
 - 3. Trend data shall be stored at the stand-alone B-ASC panels, and uploaded to hard disk storage automatically at pre-configured intervals when archival is desired.

- J. Stand-alone B-ASC panels shall automatically accumulate and store runtime hours for binary input and output points.

- K. B-ASC panels shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for user-selected analog and binary pulse input-type points.

- L. B-ASC panels shall have the ability to count and/or execute events on a daily, weekly, or monthly basis.

- M. B-ASC for VAV ATUs application shall comply with the following:
 - 1. B-ASC shall be provided with integral damper actuator. Actuator shall feature the following at a minimum:
 - a. 35 in-lbs of torque.
 - b. Brushless DC Operator.
 - c. Actual damper position feedback. Drive time or other software calculated damper position shall not be accepted.
 - d. Damper End Switch using motor current sense or equivalent for positive feedback of both end stop positions.
 - e. Software selectable rotation.
 - 2. Universal field device hardware inputs shall be provided and configured on hardware and/or in software and comply with the following:
 - a. Inputs shall accept dry-contact, thermistor, 4-20 mA, and 0-5VDC.
 - b. Pulse accumulation shall accommodate a minimum frequency of 40Hz.
 - c. Inputs shall have a minimum 10 Bit A/D conversion resolution.
 - d. 24VAC over-voltage protection.
 - 3. Hardware Outputs shall be configured on hardware and/or in software and comply with the following:
 - a. Universal Outputs shall provide configurable modulating voltage signal to industry 0-5VDC and 0-10VDC analog control devices and relays.

- b. Each TRIAC Output shall source 500 mA current, 24 VAC 0.5 ACA.
 - c. Universal Output shall be capable of sourcing 75mA at 12VDC.
 - d. Outputs shall have a minimum 8 Bit D/A conversion resolution.
 - e. 24VAC over-voltage and short protection.
4. Airflow Calibration, Test and Air Balance, etc. shall be performed via dedicated handheld configuration tool connected directly to communication port located at ATU B-ASC sensor. Special proprietary software and/or applications loaded on a computer, tablet or other similar device shall not be acceptable to perform this function.
 5. B-ASC shall provide diagnostic LEDs for power, communications and processor status. The B-ASC shall continually check the status of its processor and memory circuits.
- N. B-ASC for unitary applications shall comply with the following:
1. B-ASC shall provide diagnostic LEDs for power, communications and processor status. The B-ASC shall continually check the status of its processor and memory circuits.
 2. Controller wiring terminals shall be removable terminal strips for ease of installation and service replacement.
 3. Universal field device hardware inputs shall be provided and configured on hardware and/or in software and comply with the following:
 - a. Inputs shall accept dry-contact, thermistor, 4-20 mA, and 0-5VDC.
 - b. Pulse accumulation shall accommodate a minimum frequency of 40Hz.
 - c. Inputs shall have a minimum 10 Bit A/D conversion resolution.
 - d. 24VAC over-voltage protection.
 4. Hardware Outputs shall be configured on hardware and/or in software and comply with the following:
 - a. Universal Outputs shall provide configurable modulating voltage signal to industry 0-5VDC and 0-10VDC analog control devices and relays.
 - b. Each TRIAC Output shall source 500 mA current, 24 VAC 0.5 ACA.
 - c. Universal Output shall be capable of sourcing 75mA at 12VDC.
 - d. Outputs shall have a minimum 8 Bit D/A conversion resolution.
 5. 24VAC over-voltage and short protection.
- O. Control System Application Software:
1. The B-ASC application software shall be the same as and indistinguishable from the B-BC specified interaction with the Control System Application Software.
 2. The controller software shall reside in a real time, multi-tasking, networking operating environment. Database definition shall be accomplished through the B-AWS online with the B-ASC. The complete database and application program shall reside in the B-ASC. Configure the software to attain the proper sequence of control and to accomplish all other control system functions indicated in the Contract Documents.
 3. The user shall be able to add, delete, or modify objects on-line as required. The programming shall provide all the necessary mathematics, logic, utility and control functions necessary for proper sequence of control.
- P. Communications and Protocols

1. The B-ASC shall communicate with field devices and controllers on the BLCN using the BACnet physical data link MS/TP at 76.8 Kbps where not limited by third party devices such as variable frequency drives, utility meters, etc.
 2. The B-ASC shall provide a communications port for connection of the Portable Operators Terminal using Point-to-Point BACnet physical data link layer protocol or a connection to the inter-network.
 3. B-ASC shall support, transmit, and receive of segmented messages.
- Q. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- R. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

2.7 ENCLOSURES AND SUB-PANELS

- A. Provide pedestal base or wall mounted local control enclosure to house all control components associated with each area, system or mechanical equipment room.
1. The enclosures shall be minimum 16 gauge steel or aluminum, totally enclosed on all sides and painted with a baked enamel finish. All enclosures must maintain a minimum separation of 1" from the back wall.
 2. Enclosures located in wet indoor conditions or located outdoors shall meet NEMA 4X.
 3. Penetrations are permitted on bottom of enclosure only. Do not make conduit penetrations in top or side of enclosure. Each enclosure shall be equipped with a wire gutter below with a minimum of six 3/4" minimum conduit penetrations into the bottom of the enclosure to accommodate system wiring.
 4. Where required by AHJ, enclosures located in mechanical or electrical rooms shall meet NEMA 2 requirements.
 5. Enclosures located in all other locations including but not limited to mechanical or electrical rooms not requiring NEMA 2, occupied spaces, above ceilings and plenums shall be the same NEMA classification as all other enclosures located in the same environment, except if location requires additional protection due to potential vandalism or environmental conditions and shall at a minimum meet NEMA 1 requirements.
 6. Enclosures provided as an integral (pre-packaged) part of another product and/or piece of equipment are acceptable.
 7. Provide a continuous piano hinged door, keyed locking latch and removable sub-panel. A single key shall be common to all control enclosures.

- B. Provide each DDC panel with a line filter, surge suppressor, electrical disconnect, control fuse, and control transformer.
- C. Provide power supplies located inside control enclosures shall be fully enclosed with external 24 Vac terminals, on/off control, equipment overcurrent protection, power indication, high/low voltage separation, and convenience 120VAC outlets.
- D. Provide insulated, modular, feed-through, clamp-style terminal blocks suitable for rail-mounting with end plates and partitions for the termination of all field wiring in control enclosures. Field wiring to equipment with integral terminals and/or unitary equipment (i.e., VAVs ATUs, EFs, &c.) shall not be required to have terminal blocks.
- E. Rail mounted terminal blocks shall be color coded to match the associated conductor colors.

2.8 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Platinum RTDs: Common Requirements:
 - 1. 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
 - 2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
 - 3. Performance Characteristics:
 - a. Range: Minus 50 to 275 deg F.
 - b. Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
 - c. Repeatability: Within 0.5 deg F.
 - d. Self-Heating: Negligible.
 - 4. Transmitter Requirements:
 - a. Transmitter required for each 100-ohm RTD.
 - b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
- C. Platinum RTD, Single-Point Air Temperature Duct Sensors:
 - 1. Products: Subject to compliance with requirements, provide the following] [provide one of the following:
 - a. Minco; S400 Series PD or PF.
 - b. BEC Controls Corporation.
 - c. MAMAC Systems, Inc.
 - d. RDF Corporation.
 - 2. 100 or 1000 ohms.
 - 3. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
 - 4. Probe: Single-point sensor with a stainless-steel sheath.
 - 5. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches ((450 mm) long).
 - 6. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
 - 7. Gasket for attachment to duct or equipment to seal penetration airtight.
 - 8. Conduit Connection: 1/2-inch ((16-mm) trade size.)

- D. Platinum RTD, Air Temperature Averaging Sensors:
1. Products: Subject to compliance with requirements, provide one of the following
 - a. Minco; S400 Series PD or PF.
 - b. BEC Controls Corporation.
 - c. MAMAC Systems, Inc.
 - d. RDF Corporation.
 2. 100 or 1000 ohms.
 3. Temperature Range: Minus 50 to 275 deg F
 4. Multiple sensors to provide average temperature across entire length of sensor.
 5. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
 6. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
 7. Length: As required by application to cover entire cross section of air tunnel.
 8. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
 9. Gasket for attachment to duct or equipment to seal penetration airtight.
- E. Conduit Connection: 1/2-inch Platinum RTD Outdoor Air Temperature Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Minco; S400 Series PD or PF.
 - b. BEC Controls Corporation.
 - c. MAMAC Systems, Inc.
 - d. RDF Corporation.
 2. 100 or 1000 ohms.
 3. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
 4. Probe: Single-point sensor with a stainless-steel sheath.
 5. Solar Shield: Stainless steel.
 6. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
 7. Conduit Connection: 1/2-inch trade size.
- F. Platinum RTD Space Air Temperature Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Minco; S400 Series PD or PF.
 - b. BEC Controls Corporation.
 - c. MAMAC Systems, Inc.
 - d. RDF Corporation.
 2. 100 or 1000 ohms.
 3. Temperature Range: Minus 50 to 212 deg F
 4. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed-aluminum cover.
 5. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
 6. Concealed wiring connection.
- G. Thermal Resistors (Thermistors): Common Requirements:
1. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
 2. Two-wire, PTFE-insulated, 22-gauge stranded copper leads.
 3. Performance Characteristics:

- a. Range: Minus 50 to 275 deg F.
 - b. Interchangeable Accuracy: At 77 deg F within 0.5 deg F.
 - c. Repeatability: Within 0.5 deg F.
 - d. Drift: Within 0.5 deg F over 10 years.
 - e. Self-Heating: Negligible.
4. Transmitter optional, contingent on compliance with end-to-end control accuracy.
- H. Thermistor, Single-Point Duct Air Temperature Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Minco; TS400 Series TB.
 - b. BEC Controls Corporation.
 - c. Ebtron, Inc.
 - d. Heat-Timer Corporation.
 - e. I.T.M. Instruments Inc.
 - f. MAMAC Systems, Inc.
 - g. RDF Corporation.
 2. Temperature Range: Minus 50 to 275 deg F
 3. Probe: Single-point sensor with a stainless-steel sheath.
 4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
 5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
 6. Gasket for attachment to duct or equipment to seal penetration airtight.
 7. Conduit Connection: 1/2- inch trade size
- I. Thermistor Averaging Air Temperature Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Minco; TS400 Series TB.
 - b. BEC Controls Corporation.
 - c. Ebtron, Inc.
 - d. Heat-Timer Corporation.
 - e. I.T.M. Instruments Inc.
 - f. MAMAC Systems, Inc.
 - g. RDF Corporation.
 2. Temperature Range: Minus 50 to 275 deg F
 3. Multiple sensors to provide average temperature across entire length of sensor.
 4. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
 5. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
 6. Length: As required by application to cover entire cross section of air tunnel.
 7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
 8. Gasket for attachment to duct or equipment to seal penetration airtight.
 9. Conduit Connection: 1/2-inch trade size.
- J. Thermistor Outdoor Air Temperature Sensors:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Minco; TS400 Series TB.
 - b. BEC Controls Corporation.
 - c. Ebtron, Inc.
 - d. Heat-Timer Corporation.
 - e. I.T.M. Instruments Inc.
 - f. MAMAC Systems, Inc.

- g. RDF Corporation.
 - 2. Temperature Range: Minus 50 to 275 deg F
 - 3. Probe: Single-point sensor with a stainless-steel sheath.
 - 4. Solar Shield: Stainless steel.
 - 5. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
 - 6. Conduit Connection: 1/2-inch trade size.
 - K. Thermistor Space Air Temperature Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Minco; TS400 Series TB.
 - b. BEC Controls Corporation.
 - c. Ebtron, Inc.
 - d. Heat-Timer Corporation.
 - e. I.T.M. Instruments Inc.
 - f. MAMAC Systems, Inc.
 - g. RDF Corporation.
 - 2. Temperature Range: Minus 50 to 212 deg F
 - 3. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed-aluminum cover.
 - 4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
 - 5. Concealed wiring connection.
 - L. Space Air Temperature Sensors for Use with DDC Controllers Controlling Terminal Units:
 - 1. 100- or 1000-ohm platinum RTD or thermistor.
 - 2. Thermistor:
 - a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.
 - b. Thermistor drift shall be less than plus or minus 0.5 deg F over 10 years.
 - 3. Temperature Transmitter Requirements:
 - a. Mating transmitter required with each 100-ohm RTD.
 - b. Mating transmitters optional for 1000-ohm RTD and thermistor, contingent on compliance with end-to-end control accuracy.
 - 4. Provide digital display of sensed temperature.
 - 5. Provide sensor with local control.
 - a. Local override to turn HVAC on.
 - b. Local adjustment of temperature set point.
 - c. Both features shall be capable of manual override through control system operator.
 - M. Humidity Sensors: Bulk polymer sensor element.
 - 1. Manufacturers; Subject to compliance with requirements, provide products by one of the following:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. Vaisala.
 - 2. Accuracy: 5 percent full range with linear output.
 - 3. Room Sensor Range: 20 to 80 percent relative humidity.
 - 4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.

- b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.
 - d. Color: White.
 - e. Orientation: Vertical.
5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
 6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 40 to plus 170 deg F.
 7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

N. Pressure Transmitters/Transducers:

1. Manufacturers; Subject to compliance with requirements, provide products by one of the following:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. Setra
 - f. Vaisala.
2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 0.25-inch wg.
 - d. Duct Static-Pressure Range: 0- to 5-inch wg.
3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

O. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Sensor Protective Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

2.9 STATUS SENSORS

A. Status Inputs for Fans:

1. Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
2. Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

B. Status Inputs for Pumps:

1. Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
2. Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
 - 1. Manufacturers; Subject to compliance with requirements, provide products by one of the following:
 - a. BEC Controls Corporation.
 - b. I.T.M. Instruments Inc.

2.10 GAS DETECTION EQUIPMENT

- A. Manufacturers; Subject to compliance with requirements, provide products by one of the following:
 - 1. CEA Instruments, Inc.
 - 2. Honeywell International Inc.; Home & Building Control.
 - 3. Vaisala.
- B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- C. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

2.11 REFRIGERANT VAPOR DETECTION SYSTEM

- A. Provide a refrigerant vapor detection system to meet the latest version of ASHRAE 15 and the applicable local codes. The system shall sample and monitor a minimum of two (2) remote sampling points per Chiller.
- B. Provide the following accessories:
 - 1. One alarm relay for each level of alarm and one relay for flow failure or horn silence. Failure relay output that shall energize upon failure of monitor system operation. Failures include but are not limited to the following: low airflow through monitor, power circuit failure, and a saturated or absent sensor signal.
 - 2. Analog Output 4-20 mA or 0-5 VDC.
 - 3. Enclosure type: NEMA 4X.
- C. Sampling Tubing shall be Type L or hard drawn copper tubing.
- D. The read out/control unit shall be wall mounted pursuant with contract drawings. Remote sampling points shall be located within the central plant area according to the drawings.

2.12 WATER FLOW METERS

- A. Manufacturers; Subject to compliance with requirements, provide products by one of the following:
- B. Provide an ONICON F-3200 Series Electromagnetic Flow Meter complete with integral electronics module. The electronics module shall include a backlit graphic display and keypad. Connections to the piping shall be ANSI class 150 flanges (ANSI class 300 available where required). Provide suitable mating flanges. The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316SS; the liner shall be polypropylene or ebonite for low temperature service, PTFE for hot water service. Each flow meter shall be individually wet-calibrated and accurate to within $\pm 0.2\%$ of reading from 1.6 to 33 feet per second velocity. A certificate of calibration shall be provided with each flow meter. Output signals shall be 4-20 mA and programmable pulse. The flow meter shall be capable of measuring bi-directional flow. For installations in non-metallic pipe, install grounding rings between flanges. Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter (no special interface device or computer required). Each flow meter shall be covered by the manufacturer's two-year warranty.

2.13 DUCT AIR FLOW MEASURING STATIONS

- A. Manufacturers; Subject to compliance with requirements, provide products by one of the following:
 - 1. EBTRON, Inc.
 - 2. Onicon Incorporated.
 - 3. Approved performance equal.
- B. General:
 - 1. Provide an EBTRON, Inc. model GTx116-P+ duct airflow measuring station.
 - 2. Airflow measurement devices shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.
 - a. Thermal dispersion devices that indirectly heat a thermistor are not acceptable.
 - 3. Substitution requests for acceptance less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.
 - a. For any product to be considered for substitution, a written document shall be submitted to the engineer detailing exceptions and compliance, section-by-section with supporting documentation, before an approval will be considered.
 - b. Any product submitted as an equal shall be expected to comply with all performance capabilities and functional aspects of this specification.
 - 4. Excluded devices
 - a. Fan Inlet airflow measurement devices.
 - b. Measurement technologies using chip-in-glass, chip-in-epoxy or other chip type thermistors for the heated sensor component are not acceptable.
 - c. Pitot tubes, Pitot arrays, Piezo rings and other differential pressure based devices are not acceptable.
 - d. Vortex shedding devices are not acceptable.
- C. Required product performance:
 - 1. Airflow Measurement Devices (AMD) with Temperature Output and Airflow Alarming Capability
 - 2. General
 - a. Provide one AMD for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.

- b. Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.
 - 1) Devices that have electronic signal processing components on or in the sensor probe are not acceptable.
 - c. Airflow measurement shall be field configurable to determine the average Actual or Standard mass airflow rate.
 - 1) Actual airflow rate calculations shall have the capability of being corrected by the transmitter for altitudes other than sea level.
 - d. Temperature measurement shall be field configurable with velocity weighted average as the default, or manual selection of arithmetic average temperature.
3. Sensor Probes
- a. Sensor probes shall be constructed of gold anodized, 6063 aluminum alloy tube, 316 stainless steel tube are available when required.
 - b. Sensor probe mounting brackets shall be constructed of 304 stainless steel.
 - c. Probe internal wiring between the connecting cable and sensor nodes shall be Kynar coated copper.
 - 1) PVC jacketed internal wiring is not acceptable.
 - d. Probe internal wiring connections shall consist of solder joints and spot welds.
 - 1) Internal wiring connections shall be sealed and protected from the elements. They shall be capable of direct exposure to water without affecting instrument operation.
 - 2) Connectors of any type within the probe are not acceptable.
 - 3) Printed circuit boards within the probe are not acceptable.
 - e. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/cUL Listed cable rated for exposures from -67° F to 392° F (-55° C to 200° C) and continuous and direct UV exposure.
 - 1) Plenum rated PVC jacket cables are not acceptable.
 - f. Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.
 - g. Each sensor probe shall contain one or more independently wired sensing nodes.
 - h. Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter in the field.
 - i. Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Upon request, the manufacture shall provide a written independent laboratory test result of 100% survival rate in a 30 day saltwater and acid vapor test.
 - 1) Devices that use epoxy or glass encapsulated chip thermistors are not acceptable.
 - 2) Devices with exposed leads are not acceptable.
 - j. Each thermistor shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.
 - k. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of $\pm 2\%$ of reading over the entire calibrated airflow range of 0 to 5,000 FPM.
 - 1) Upon request the manufacture shall submit for AMD approval a copy of the NIST report of calibration used for the reference standard used.
 - a) Devices claiming NIST traceability to third party laboratories and not directly to NIST are not acceptable.
 - b) Devices calibrated against standards other than the NIST LDA are not acceptable.

- l. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.
 - m. The installed airflow accuracy shall be:
 - 1) Ducts - $\pm 3\%$ of reading when installed in accordance with the manufactures recommended placement guidelines.
 - 2) Non-ducted Outdoor Air intakes \geq better than or equal to $\pm 5\%$ of reading when installed in accordance with the manufactures recommended placement guidelines.
 - n. Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with this requirement over the entire operating range.
 - o. Each sensing node shall have a temperature accuracy of $\pm 0.15^\circ \text{ F}$ (0.08° C) over an operating range of -20° F to 160° F . (-28.9° C to 71.1° C) and humidity range of 0 to 100% RH.
4. Transmitter
- a. A remotely located microprocessor-based transmitter shall be provided for each measurement location.
 - b. The transmitter shall be comprised of a main circuit board and interchangeable interface card.
 - c. All printed circuit board interconnects, edge fingers, receptacle plug pins and PCB test points shall be gold plated.
 - d. All printed circuit boards shall be electroless nickel immersion gold (ENIG) plated.
 - e. All integrated circuitry shall be temperature rated as \geq industrial-grade. Submissions containing \geq commercial-grade integrated circuitry are not acceptable.
 - f. The transmitter shall be capable of determining the airflow rate and temperature average of all connected sensor nodes in an array for a single location.
 - 1) Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (IR-interface).
 - g. The transmitter shall be capable of providing a high and/or low airflow alarm with user-defined set point and % of set point tolerance. Alarm shall be capable of being manually or automatically reset and low-limit cutoff value may be selected to disable the alarm. An alarm delay function shall also be field defined.
 - h. The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.
 - i. The transmitter shall be capable of field configuration, diagnostics and include Field Output Adjustment Wizard that allows for a one or two point field adjustment to factory calibration for installations that require adjustment.
 - j. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.
 - k. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals (AO1=airflow, AO2=temperature or alarm), in combination with either of the following:
 - 1) one isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection
 - 2) one isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection
 - l. The analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate and the second output (AO2) shall be field configurable to provide temperature information.
 - m. The transmitter shall also be available with a single isolated LonWorks Free Topology network interface. Transmitters shall be available alternatively with one USB connection for thumb-drive data logging of sensor data. Neither of these options shall include analog output signals.
 - n. The network communications RS-485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, hi and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures. Individual node airflow rates and temperatures shall NOT be available via the network with Lon.

- o. The transmitter shall have an on-off power switch. Isolation transformers shall not be required.
 - p. The transmitter shall be powered by 24 VAC (22.8 to 26.4 under load) @20 V-A maximum and use a switching power supply that is over-current and over-voltage protected.
 - q. The transmitter shall use a Watchdog timer circuit to ensure automatic reset after power disruption, transients and brown-outs.
 - r. Each transmitter shall have an operating temperature range of -20° F to 120° F (-28.9° C to 48.9° C) and humidity range of 5 to 95% RH.
5. Listings and Certifications
- a. The AMD shall be UL/cUL 873 Listed as an assembly.
 - 1) Devices claiming compliance with the UL Listing based on individual UL component listing are not acceptable.
 - b. All network-capable AMD models supplied with RS-485 interface and BACnet protocol shall be BTL Listed.
 - c. The AMD shall be tested for compliance with the EMC Directive's requirements and be certified to carry the CE Mark for European Union Shipments.
6. Installation
- a. Install in accordance with manufacturer's placement guidelines. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.

2.14 FAN AIR FLOW MEASURING STATIONS

- A. Manufacturers; Subject to compliance with requirements, provide products by one of the following:
- 1. EBTRON, Inc.
 - 2. Onicon Incorporated.
 - 3. Approved performance equal.
- B. General
- 1. Provide an EBTRON, Inc. model GTx108-F fan airflow measuring device.
 - 2. Airflow measurement devices shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.
 - a. Thermal dispersion devices that indirectly heat a thermistor are not acceptable.
 - 3. Substitution requests for acceptance less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.
 - a. For any product to be considered for substitution, a written document shall be submitted to the engineer detailing exceptions and compliance, section-by-section with supporting documentation, before an approval will be considered.
 - b. Any product submitted as an equal shall be expected to comply with all performance capabilities and functional aspects of this specification.
 - 4. Excluded devices
 - a. Fan Inlet airflow measurement devices.
 - b. Measurement technologies using chip-in-glass, chip-in-epoxy or other chip-type thermistors for the heated sensor component are not acceptable.
 - c. Pitot tubes, Pitot arrays, Piezo rings and other differential pressure based devices are not acceptable.
 - d. Vortex shedding devices are not acceptable.
- C. Required product performance
- 1. Airflow Measurement Devices (AMD) with Temperature Output and Airflow Alarming Capability
 - 2. General

- a. Provide one AMD for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.
 - b. Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.
 - 1) Devices that have electronic signal processing components on or in the sensor probe are not acceptable.
 - c. Airflow measurement shall be field configurable to determine the average Actual or Standard mass airflow rate.
 - 1) Actual airflow rate calculations shall have the capability of being corrected by the transmitter for altitudes other than sea level.
 - d. Temperature measurement shall be field configurable with velocity weighted average as the default, or manual selection of arithmetic average temperature
3. Sensor probes
- a. Sensor probes shall consist of one sensor node mounted on a 304 stainless steel block with two adjustable zinc plated steel rods connected to 304 stainless steel pivoting mounting feet.
 - b. Sensor node internal wiring connections shall be sealed and protected from the elements and suitable for direct exposure to water.
 - c. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/cUL Listed cable rated for exposures from -67°F to 392 °F (-55° C to 200° C) and continuous and direct UV exposure.
 - 1) Plenum rated PVC jacket cables are not acceptable.
 - d. Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.
 - e. Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter in the field.
 - f. Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Upon request, the manufacture shall provide a written independent laboratory test result of 100% survival rate in a 30 day saltwater and acid vapor test.
 - 1) Devices that use epoxy or glass encapsulated chip thermistors are not acceptable.
 - 2) Devices with exposed leads are not acceptable.
 - g. Each thermistor shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.
 - h. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of $\pm 2\%$ of reading over the entire calibrated airflow range of 0 to 10,000 FPM.
 - 1) Upon request the manufacture shall submit for AMD approval a copy of the NIST report of calibration used for the reference standard used.
 - a) Devices calibrated against standards other than the NIST LDA or against NIST temperature standards only are not acceptable.
 - 2) Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.
 - 3) Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with this requirement over the entire operating range.

- i. Each sensing node shall have a temperature accuracy of $\pm 0.15^\circ\text{F}$ (0.08°C) over an operating range of -20°F to 160°F (-28.9°C to 71.1°C) and humidity range of 0 to 100% RH.
 - j. The number of independent sensor nodes provided shall be as follows:
 - 1) SWSI and DWDI fans: 2 probes x 1 sensor node/per probe in each fan inlet
 - 2) Fan Arrays (1 to 8 fans): 2 probes x 1 sensor node probe in each fan inlet
4. Transmitter
- a. A remotely located microprocessor-based transmitter shall be provided for each measurement location.
 - b. The transmitter shall be comprised of a main circuit board and interchangeable interface card.
 - c. All printed circuit board interconnects, edge fingers, and test points shall be gold plated.
 - d. All printed circuit boards shall be electroless nickel immersion gold (ENIG) plated.
 - e. All integrated circuitry shall be temperature rated as $\dot{\text{U}}$ industrial-grade $\dot{\text{C}}$. Submissions containing $\dot{\text{U}}$ commercial-grade $\dot{\text{C}}$ integrated circuitry are not acceptable.
 - f. The transmitter shall be capable of determining the airflow rate and temperature of each fan
 - 1) Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (IR-interface).
 - g. The transmitter shall have startup firmware to facilitate setup of multiple fans and fan areas.
 - h. The transmitter shall be capable of providing a low and/or high airflow set point alarm.
 - i. The transmitter shall be capable of providing individual fan alarming on fan array configurations.
 - j. The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.
 - k. The transmitter shall be capable of field configuration, diagnostics and include Field Output Adjustment Wizard that allows for a one or two point field adjustment to factory calibration for installations that require adjustment.
 - l. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.
 - m. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals (AO1=airflow, AO2=temperature or alarm), in combination with either of the following:
 - 1) One isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection
 - 2) One isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection
 - n. Analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate; while the second output (AO2) shall be field configurable to provide temperature.
 - o. The transmitter shall also be available with a single isolated LonWorks Free Topology network interface. Transmitters shall be available alternatively with one USB connection for thumb-drive data logging of sensor data. Neither of these options shall include analog output signals.
 - p. Network communications RS 485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, hi and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures. Individual node airflow rates and temperatures shall be available via the network with Lon.
 - q. The transmitter shall have an on-off power switch. Isolation transformers shall not be required.
 - r. The transmitter shall be powered by 24 VAC (22.8 to 26.4 under load) @16 V-A maximum and use a switching power supply that is over-current and over-voltage protected.
 - s. The transmitter shall use a $\dot{\text{O}}$ watchdog $\dot{\text{C}}$ timer circuit to ensure automatic reset after power disruption, transients and brown-outs.
 - t. Each transmitter shall have an operating range of -20°F to 120°F (-28.9°C to 48.9°C) and humidity range of 5 to 95% RH.

5. Listing and Certifications
 - a. The AMD shall be UL/cUL 873 Listed as an assembly;
 - 1) Devices claiming compliance with the UL Listing based on individual UL component listing are not acceptable.
 - b. All network-capable AMD models supplied with RS-485 interface and BACnet protocol shall be BTL Listed
6. Installation
 - a. Install in accordance with manufacturer's placement guidelines. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.

2.15 THERMOSTATS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Erie Controls.
 2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
 3. Heat-Timer Corporation.
 4. Honeywell Controls.
 5. Sauter Controls Corporation.
 6. tekmar Control Systems, Inc.
 7. Theben AG - Lumilite Control Technology, Inc.
- B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
 1. Automatic switching from heating to cooling.
 2. Preferential rate control to minimize overshoot and deviation from set point.
 3. Set up for four separate temperatures per day.
 4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
 5. Short-cycle protection.
 6. Programming based on every day of week.
 7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
 8. Battery replacement without program loss.
 9. Thermostat display features include the following:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System mode indications include "heating," "off," "fan auto," and "fan on."
- C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
- D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
 1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 2. Selector Switch: Integral, manual on-off-auto.
- E. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

2.16 HUMIDISTATS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. MAMAC Systems, Inc.
 2. ROTRONIC Instrument Corp.
- B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.17 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Belimo Aircontrols (USA), Inc.
 - b. Siemens.
 - c. Johnson Controls.
 - d. Alerton.
 - e. Delta Controls.
 - f. IMI TA / Victaulic.
 2. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 3. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 4. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 5. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
 6. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 7. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
 8. Smoke Dampers:
 - a. Size for torque required for damper seal at load conditions with one actuator per damper section. Mechanically paralleled or 'piggybacked' actuators are not permitted.
 - b. Coupling: V-bolt dual nut clamp with a V-shaped toothed cradle. Aluminum clamps or set screws are not acceptable.
 - c. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
 - d. Power Requirements: 0.23A (running) and 0.09A (holding) at 24V-ac or 27 VA (running) and 10 VA (holding) at 120V-ac.

- e. Actuator timing shall be 15 seconds or as required by local codes, whichever is more stringent.
 - f. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 350°F
 - g. Proportional Smoke Damper Actuators shall meet all requirements specified above and shall modulate 0-100% open in response to a 2-10vdc or 4-20mA control signal. A 2-10vdc feedback output shall provide a 2-10vdc signal for position indication.
 - 1) Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc.
 - 2) A manual override winder and locking mechanism shall be provided for override operation of the actuator on a loss of power.
9. Combination Fire Smoke Dampers:
- a. Size for torque required for damper seal at load conditions.
 - b. Coupling: V-bolt dual nut clamp with a V-shaped toothed cradle. Aluminum clamps or set screws are not acceptable.
 - c. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
 - d. Power Requirements: 0.23A (running) and 0.09A (holding) at 24V-ac or 27 VA (running) and 10 VA (holding) at 120V-ac.
 - e. Actuator timing shall be 15 seconds or as required by local codes, whichever is more stringent.
 - f. Temperature Rating: Actuator shall have UL555 and UL555S listings by the damper manufacturer for 350°F.
 - g. Proportional Combination Fire and Smoke Damper Actuators shall meet all requirements specified above and shall modulate 0-100% open in response to a 2-10vdc or 4-20mA control signal. A 2-10vdc feedback output shall provide a 2-10vdc signal for position indication.
 - 1) Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc.
 - 2) A manual override winder and locking mechanism shall be provided for override operation of the actuator on a loss of power.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Belimo Aircontrols (USA), Inc.
 - 2. Honeywell Controls Inc.
 - 3. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 4. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 - 5. Coupling: V-bolt and V-shaped, toothed cradle.
 - 6. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 7. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 - 8. Power Requirements (Two-Position Spring Return): 24 or 120]-V ac.
 - 9. Power Requirements (Modulating): Maximum 25 VA at 24-V ac or 8 W at 24-V dc.

10. Proportional Signal: 0- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
11. Temperature Rating: [Minus 22 to plus 122 deg F] [40 to 104 deg F].
12. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
13. Run Time: 12 seconds open, 5 seconds closed.
14. The manufacturer shall provide 5-year limited warranty from the date of sale covering defects in material or workmanship.
15. All actuators are to be delivered with a detailed written installation instruction.

2.18 CONTROL VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Belimo Aircontrols (USA), Inc.
 2. Siemens.
 3. Johnson Controls.
- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Hydronic System Characterized Ball valves shall have the following characteristics:
 1. 2" and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL or stainless steel flow characterizing disc.
 2. 2-1/2" through 6" : GG25 cast iron body, ANSI 125, class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
 3. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
 4. Sizing: [3-psig] [5-psig] <Insert value> maximum pressure drop at design flow rate or the following:
 - a. Two Position: Line size.
 - b. Two-Way Modulating: Twice the load pressure drop, but not more than value specified above.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
 5. Valve assemblies shall be maintenance free.

2.19 DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Air Balance Inc.
 2. TAMCO (T. A. Morrison & Co. Inc.).
 3. Vent Products Company, Inc.
- B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch-minimum thick, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
 1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 2. Operating Temperature Range: From minus 40 to plus 200 deg F.
 3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 TEMPERATURE INSTRUMENT APPLICATIONS

- A. Air Temperature Sensors:
 1. Duct, Thermistor 100-ohm platinum RTD.
 2. Outdoor, : Thermistor 100-ohm platinum RTD.
 3. Space, : Thermistor 100-ohm platinum RTD.
- B. Air Temperature Transmitters:
- C. Liquid Temperature Sensors:
 1. Chilled Water, Energy recovery Water, and Heating Hot Water Systems, Liquid temperature sensor, commercial grade.
- D. Liquid and Temperature Transmitters:
 1. Chilled Water, Energy recovery Water, and Heating Hot Water Systems, Liquid temperature transmitter, commercial grade.

3.3 GENERAL

- A. All control system components shall be installed in locations as required to properly sense the controlled medium.
- B. BAS Installation shall be performed by professionals in a workmanlike manner and in compliance with the Contract Documents, Division 26 Project Electrical System Specifications, the National Electric Code (NEC), and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ) and the following:
 1. Complete BAS installation including all DDC Devices, Enclosures, wiring, equipment, control devices and sensors shall be installed in accordance with the manufacturers' recommended installation procedures and as specified.
 2. All control devices are to be provided and installed with all required gaskets, seals, flanges, connection enclosures, thermal compounds, insulation, piping, fittings and valves as required for design operation, isolation, equalization, purging and calibration.
 3. Strap-on control devices shall not be permitted except as explicitly called out.
 4. All control devices mounted outdoors shall be protected by a weather-shield, integral outdoor enclosure, from ambient elements in such a manner as to not impede design functionality and/or sensing.
 5. BAS installation shall be such that it provides sufficient clearance for system maintenance by maintaining sufficient access for equipment, device and/or component service, calibration, removal, repair or replacement.
 6. BAS installation shall not interfere with required clearance for mechanical and/or electrical equipment maintenance.
 7. Penetrations through and mounting holes in the building exterior associated with the BAS installation shall be sealed and made water-tight.
 8. Dielectric isolation shall be provided where dissimilar metals are used in installation for connection and support.

- C. Installation, wiring and material shall be protected from damage or theft before, during, and after installation. Any damaged or stolen installation, wiring, or material shall be repaired or replaced.
- D. After completion of installation, calibrate and commission all components provided as part of the Control System and demonstrate proper sequence of operation in compliance with the specifications. BAS components not operating correctly shall be field corrected or replaced.

3.4 BAS APPLICATION SOFTWARE

- A. At time of acceptance all operating system, Third party and Control System Application software shall be at least the latest official release version available.
- B. Software programs are described to their general intent. It is recognized that Networked System manufacturer's software differ; however, the Application software provided shall incorporate the features described fully implemented and optimized to provide the sequences described, minimize energy consumption and prolong equipment life.
- C. When programming the system BACnet addressing rules will be strictly adhered to. All addressing strategies will have to be approved by Owner and Engineer of Record prior to configuring any LAN types.
- D. All analog and binary values shall be programmed with appropriate alarms.
- E. Except as specified otherwise, throttling ranges, proportional bands, and switching differentials shall be centered on the associated set point.
- F. All set points unless otherwise indicated are adjustable and shall be programmable for all control loops.
- G. Each control loop and/or interlock(s) for all mechanical system including terminal unit systems shall be programmed with a control loop specific graphical trend to trend all values associated with each specific control loop or system interlock.
- H. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the system start commands shall be staggered by 15-second (adj.) intervals to minimize inrush current.
- I. Scheduling shall be developed for each mechanical system. Final schedules shall be coordinated with the Owner and Engineer of Record prior to system commissioning.
- J. Optimal start/stop programs shall be applied to all regularly scheduled mechanical and electrical systems.
- K. At a minimum, trend log/historical data shall be implemented for every hardware point on the system. Additionally all software (virtual) points used as setpoints shall be trended. Point trends shall be grouped into logically interrelated points for individual mechanical and building systems. Initial set-up shall be to log values once every 5 minutes.
- L. B-AWS Graphical User Interface (GUI) must be approved by the Owner and Engineer of Record and shall incorporate at a minimum the following:
 - 1. At a minimum, all physical hardware, sensors, control devices and set points shall be visible on a B-AWS in graphical form.
 - 2. All mechanical systems shall have a programmed real time color graphic for primary graphical user interface.
 - 3. Individual floor plan graphics will be programmed for each floor and area of the building. All space sensors shall be visible on floor plan graphics and system graphic.

3.5 B-AWS HARDWARE

- A. Provide as specified for each PC-Based B-AWS.
- B. Assemble server components in a configuration that allows easy operator access to all necessary components from one position.
- C. Provide sufficient permanent and removable storage drives for 25% free memory after provision for all operating system, Third party and Control System Application software, all fully configured point databases, storage/back-up of all B-BC, B-AAC and B-ASC application programming, all graphic files, all user-defined reports and a three year archive of all trend and historical data described in this specification.
- D. Provide sufficient RAM to meet system performance requirements.

3.6 BACnet PROTOCOL VERIFICATION SOFTWARE

- A. Demonstrate exclusive communication utilizing the BACnet Protocol on all segments of the BACnet network.

3.7 BUILDING CONTROLLER (B-BC)

- A. Provide as required to meet performance requirements of the system with a 10% increase in connected B-AAC and B-ASC on any individual network. Provide a dedicated B-BC for all project specific equipment requiring this controller type.
- B. Locate strategically such that B-BC locations are as equally distributed throughout the project as possible.

3.8 ADVANCED APPLICATION CONTROLLERS (B-AAC)

- A. Provide a dedicated B-AAC for each medium-sized mechanical system.
- B. All points used for a single mechanical system shall be connected to the same B-AAC. Points used for control loop reset based on outside air, or space/zone temperature, or extremely remote differential pressure sensors on slow acting control loops are exempt from this requirement.
- C. Provide spare additional I/O such that future use of spare capacity shall require providing only the field device, field wiring, point database definition and operational sequence programming changes as required. Additional point modules may be required to implement use of these spare points.
 - 1. Provide at least one (1) spare universal input and one (1) spare universal output or 5% spare I/O of the total capacity of each B-AAC whichever is greater.
 - 2. If B-AAC I/O is not universal then provide at least one (1) spare analog input, one (1) spare digital input, one (1) spare analog output and one (1) spare digital output or 5% spare I/O of the total capacity for each point type of each B-AAC whichever is greater.

3.9 APPLICATION SPECIFIC CONTROLLERS (B-ASC)

- A. Provide a dedicated B-ASC for each Terminal Unit Mechanical Device on the project, including VAV and Fan Powered Terminal Units, Unit Heaters, and Individual Fans.
- B. All points used for a single Terminal Unit Mechanical Device shall be connected to a dedicated B-ASC. Points used for control loop reset based on outside air, or space/zone temperature, or extremely remote differential pressure sensors on slow acting control loops are exempt from this requirement.
- C. VAV ATU and FP-VAV ATU Controllers

1. Provide networked B-ASC for each VAV ATU and FP-VAV ATU consisting of a controller, damper actuator, and velocity transducer.
2. The ATU shall be provided with multi-point averaging type flow sensor factory piped to the velocity transducer.

3.10 LOCAL SYSTEM NETWORK INTERFACE

- A. At a minimum the Portable B-AWS shall be able to connect to the BACnet Internetwork within each mechanical equipment space within the project.

3.11 ENCLOSURES & SUB-PANELS

- A. All system components not designed for or required to be field installed shall be mounted in a control enclosure. Those components shall be sub panel mounted except components that are mounted on the panel face. Provide on/off power switch with over-current protection for control power sources in each local enclosure.
- B. All control enclosures shall be located so that visual observation and adjustment can be accomplished while standing flatfooted on the floor in a convenient location adjacent to the equipment served. Install all equipment in readily accessible location as defined by Chapter1 Article 100 Part A of the NEC.
- C. Label all control system components.
- D. A copy of the ÓAs-built application engineering for the system served shall be laminated in clear plastic, shall be legible and suspended within enclosure.
- E. All B-BC shall be mounted in an enclosure.

3.12 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats in the following locations:
 1. Entrances.
 2. Public areas.
 3. Where indicated.
- E. Install automatic dampers according to Section 233300 "Air Duct Accessories."
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."
- H. Install hydronic instrument wells, valves, and other accessories according to Section 232116 Hydronic Piping Specialties."

- I. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."
- J. Install duct volume-control dampers according to Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."
- K. Install electronic and fiber-optic cables according to Section 271500 "Communications Horizontal Cabling."

3.13 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. General

- 1. Provide all wiring required for a complete Control System.
- 2. Control system wiring and cabling installed for this project shall be performed by professionals in a workmanlike manner and in accordance with the Contract Documents, Division 26 Project Electrical System Specifications, the National Electric Code (NEC), and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ) and shall include but may not be limited to the following:
 - a. All power wiring required not indicated on the electrical plans and specifications.
 - b. Power to all actuators and sensors.
 - c. Provide all wiring and cabling for network communications except for owner provided LAN's/WAN's.
 - d. All sensor and control device input and output wiring.
 - e. All interconnecting cabling between and amongst network devices, PCs printers, etc.
 - f. Interlock wiring between devices, variable frequency drives and between motor starters.
 - g. All other necessary wiring for fully complete and functional system as specified.
 - h. Install piping, wiring/cabling routed parallel to or at right angles with the structure, properly supported every six (6) feet at a minimum and installed in a workmanlike manner.
- 3. Maximum allowable voltage for control wiring shall be 120-volts.
- 4. All wiring shall be installed as continuous links. Any required splices shall be made only within an approved junction box or other approved protective device with a maximum fill of 50%.
 - a. BACnet network cabling shall not be field spliced.
- 5. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- 6. Terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

B. Power Wiring and Cabling

- 1. Obtain power and provide wiring for all enclosures and controls equipment, including branch circuit wiring from circuit breaker panels unless specifically shown on the Plans or Specifications to be provided under Division 26.
- 2. All B-AWS equipment shall be served from isolated ground receptacles via UPS by dedicated branch circuits.
- 3. All other enclosures, sensor and control devices shall be fed from separate circuits in the electrical distribution panels and shall not be served from the typical floor receptacle or lighting circuits.

C. Network Wiring and Cabling

- 1. Network installation shall strictly adhere to the manufacturer's networking installation instructions and procedures.
- 2. Network installation shall conform to standards for the LAN types and cabling types selected. Specific network rules inherent to the ANSI/AHRAE Standard 135-1995, BACnet shall be followed. Those include but are not limited to:
 - a. Only one path can exist from any BACnet device to another.
 - b. Each BACnet device connected to an internetwork LAN must have a unique device instance (0 - 4,194,303).
 - c. Each internetwork LAN must have a unique Network Number (1 - 65,545).

3. Primary LAN Network wire and cable shall be run separately from all other wiring.
4. Other LAN Network wire and cabling shall be installed separate from any wiring over thirty (30) volts.
5. All communications shielding shall be grounded as per Networked System manufacturer's recommendations.

D. Installation

1. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."
2. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
3. Install signal and communication cable according to Section 271500 "Communications Horizontal Cabling."
 - a. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - b. Install exposed cable in raceway.
 - c. Install concealed cable in raceway.
 - d. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - e. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - f. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - g. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
4. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
5. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.14 ANALOG SENSORS

A. Temperature

1. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
2. Install and properly support all enclosures and sensing elements as much as possible in the center of duct cross section and in straight duct runs. In condensing environments use stainless steel flanges to support sensing elements.
3. Sensors mounted on air ducts having exterior insulation shall be provided with handy-box mounting with insulating material firmly fitted around handy-box.
4. Averaging type sensors: provide a minimum of 1 linear foot of sensor per 4 square feet of duct/coil area or equal to duct/coil width where installed, whichever is longer. Averaging sensing tubing shall serpentine vertically across airstream and be supported firmly by mechanical clips.
5. Temperature sensors installed in piping or tanks shall be in separable thermowells. Sensors shall be inserted into thermowells with conductive paste. Assembly shall allow removal of sensor without loss of fluid.
6. At a minimum one outside air temperature sensor shall be installed. It shall be mounted outside on a northern exposure as high as serviceable on the building. The sensor shall be mounted within a ventilated enclosure to shield the sensor from the effects of the sun. The sensor location shall be selected such that it may not be affected by artificial and/or mechanical airstreams (i.e., building exhaust, building relief, etc.).
7. Terminal Unit Sensors shall be provided one per terminal unit device.
 - a. They shall be wall mounted in the space served 60" above finished floor and located as shown on drawings.
 - b. Provide a minimum of 16 inches of coiled temperature sensor control wiring for equipment with space sensor not located on the Drawings.

8. In all areas where terminal unit sensor locations are not known at the time of building startup, sensors shall be hung approximately 24 inches from the ceiling in the area of the controlled zone and connected. Control wiring shall be neatly coiled and attached to ceiling grid.
9. Zone temperature sensors shall not be located on perimeter walls. Where explicitly indicated on drawings to do so and/or in locations near exterior walls and/or subject to drafts sensors shall have insulated mounting bases to prevent false room temperature readings.
10. Where wall sensors are mounted in an area subject to damage provide suitable protective guard.
11. Where wall sensors are mounted in public spaces with adjustable set points provide suitable security guard.

B. Wet Bulb

1. For outside air mount same as outside air temperature sensor.
2. For duct mounting execute same as duct mounted temperature sensor.

C. Pressure

1. Orient static pressure sensing taps faced directly down-stream in the airflow so as to eliminate velocity pressure effects. Locate pressure transducers within 10¢ of sensing point and use tubing sized such as to prevent signal phase lag.
 - a. Final location of static/differential pressure sensing taps shall be pursuant with Contract Documents and as indicated on drawings. Where not explicitly indicated on drawings, pressure sensing taps shall be located as follows:
 - 1) Duct static pressure control sensor tap shall be located 2/3 distance from the Air Handling Unit of the total duct length in a straight section of ductwork with a minimum of four (4) duct diameters in both directions.
 - 2) Positive static high-pressure safety cut-outs shall be located at Air Handling Unit immediately downstream of fan section.
 - 3) Mixed-Air static and/or differential sensor tap shall be located in mixing box section.
 - 4) Negative static pressure safety cut-outs shall be located immediately upstream of fan section.
 - 5) Filter differential pressure taps shall be installed on both filter inlet and outlet.
 - b. Mount air differential pressure taps so that true differential is sensed.
2. Water gauge taps shall include snubbers and isolation valves.
3. Water differential pressure sensors shall be piped through a five-valve bypass assembly with snubbers.

3.15 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each system for compliance with sequence of operation.
 5. Test software and hardware interlocks.
- C. DDC Verification:
 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check installation of air supply for each instrument.
 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 8. Check temperature instruments and material and length of sensing elements.
 9. Check control valves. Verify that they are in correct direction.
 10. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.16 CALIBRATION, COMMISSIONING, DEMONSTRATION AND ACCEPTANCE

A. Commissioning, Calibrating and Adjusting:

1. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated. Confirm in writing to the Owner and Architect the compliance with the field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components" .
2. Pretest Checklist and Test Plan
 - a. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
 - b. After approval by Owner or Architect of the Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.
 - c. After testing is complete, submit completed Pretest Checklist.
 - d. Pretest Checklist: Submit the following list with items checked off once verified:
 - 1) Detailed explanation for any items that are not completed or verified.
 - 2) Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
 - 3) HVAC equipment motors operate below full-load amperage ratings.
 - 4) Required DDC system components, wiring, and accessories are installed.
 - 5) Installed DDC system architecture matches approved Drawings.
 - 6) Control electric power circuits operate at proper voltage and are free from faults.
 - 7) Required surge protection is installed.
 - 8) DDC system network communications function properly, including uploading and downloading programming changes.
 - 9) Using BACnet protocol analyzer, verify that communications are error free.
 - 10) Each controller's programming is backed up.
 - 11) Equipment, products, tubing, wiring cable, and conduits are properly labeled.
 - 12) All I/O points are programmed into controllers.
 - 13) Testing, adjusting, and balancing work affecting controls is complete.
 - 14) Dampers and actuators zero and span adjustments are set properly.
 - 15) Each control damper and actuator goes to failed position on loss of power and loss of signal.
 - 16) Valves and actuators zero and span adjustments are set properly.
 - 17) Each control valve and actuator goes to failed position on loss of power and loss of signal.
 - 18) Meter, sensor, and transmitter readings are accurate and calibrated.
 - 19) Control loops are tuned for smooth and stable operation.

- 20) View trend data where applicable.
 - 21) Each controller works properly in standalone mode.
 - 22) Safety controls and devices function properly.
 - 23) Interfaces with fire-alarm system function properly.
 - 24) Electrical interlocks function properly.
 - 25) Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.
 - 26) Record Drawings are completed.
- e. Test Plan:
- 1) Prepare and submit validation Test Plan including test procedures for performance validation tests.
 - 2) Address all specified functions of DDC system and sequences of operation in Test Plan.
 - 3) Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
 - 4) Explain method for simulating necessary conditions of operation used to demonstrate performance.
 - 5) Include Test Checklist to be used to check and initial that each test has been successfully completed.
 - 6) Submit Test Plan documentation twenty business days before start of tests.
3. Fully commission the entire BAS. All commissioning shall be fully documented and all documentation shall be submitted prior to Demonstration and Acceptance testing.
- a. Commissioning shall include a point-to-point • check-out of all I/O points in the DDC system.
 - b. Verify that all Temperature Control Panels (TCP), BAS equipment, controllers, devices and sensors are installed and operational according to the specifications, submittals and manufacturer's installation and application instructions.
 - c. Calibrate all inputs by comparing the actual site condition with the B-AWS point display.
 - d. Verify all outputs from B-AWS command to observed response of controlled device.
 - e. Verify failure response and fail-safe conditions of all devices and safeties.
 - f. Each control program shall be fully commissioned and tested for complete design intent compliance and functionality.
 - 1) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
 - g. Verify overall network performance of BAS for complete design intent compliance and functionality with all devices on-line, communicating and fully-operational.
 - h. Subsystems not directly controlled by the BAS but associated with the ATC shall also be fully tested and commissioned as to design intent compliance and functionality.
 - i. Validation Test:
 - 1) Verify operating performance of each I/O point in DDC system.
 - a) Verify analog I/O points at operating value.
 - b) Make adjustments to out-of-tolerance I/O points.
 - c) Identify I/O points for future reference.
 - d) Simulate abnormal conditions to demonstrate proper function of safety devices.
 - e) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
 - 2) Simulate conditions to demonstrate proper sequence of control.
 - 3) Readjust settings to design values and observe ability of DDC system to establish desired conditions.
 - 4) 24 hours after initial validation test, do as follows:
 - a) Re-check I/O points that required corrections during initial test.
 - b) Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

- 5) 24 Hours after second validation test, do as follows:
 - a) Re-check I/O points that required corrections during second test.
 - b) Continue validation testing until I/O point is normal on two consecutive tests.
 - 6) Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
 - 7) After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.
- j. DDC System Response Time Test:
- 1) Simulate HLC.
 - a) Heavy load to be occurrence of 50 percent of total connected binary COV, one-half of which represents "alarm" condition, and 50 percent of total connected analog COV, one-half of which represents "alarm" condition, that are initiated simultaneously on a one-time basis.
 - 2) Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
 - 3) Measure with timer having at least 0.1-second resolution and 0.01 percent accuracy.
 - 4) Purpose of test is to demonstrate DDC system, as follows:
 - a) Reaction to COV and alarm conditions during HLC.
 - b) Ability to update DDC system database during HLC.
 - 5) Passing test is contingent on the following:
 - a) Alarm reporting at printer beginning no more than two seconds after initiation (time zero) of HLC.
 - b) All alarms, both binary and analog, are reported and printed; none are lost.
 - c) Compliance with response times specified.
 - 6) Prepare and submit report documenting HLC tested and results of test including time stamp and print out of all alarms.
- k. DDC System Network Bandwidth Test:
- 1) Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
 - 2) To pass, none of DDC system networks are to use more than 70 percent of available bandwidth under normal and HLC operation.
4. Calibrate instruments.
- a. Make three-point calibration test for both linearity and accuracy for each analog instrument.
5. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
6. Control System Inputs and Outputs:
- a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
7. Flow:
- a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.

8. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
9. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
10. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
11. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
12. Provide diagnostic and test instruments for calibration and adjustment of system.
13. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

D. Demonstration and Acceptance

1. Demonstrate compliance of the BAS with the contract documents and operational functionality pursuant with the design Sequences of Operation. Using the documented calibration and commissioning test data the Owner and/or its representative shall select, at random, results to be demonstrated. At least 95% of the results demonstrated must perform as specified and documented on commissioning data sheets or the system must be re-calibrated and re-commissioned before being re-tested.
2. When the Calibration, Commissioning, Demonstration and Acceptance process has been completed and approved by Owner, obtain signed letter from Owner indicating Acceptance within thirty (30) days of approval.

3.17 TRAINING

A. Refer to Section 017900 "Demonstration and Training."

B. Provide instruction on the adjustment, operation and maintenance of the BAS as installed including all hardware and software provided by a manufacturer-trained, competent application engineer and/or technician with sufficient experience in the installation, programming and operation of the BAS. Provide all training equipment and material.

C. Training Schedule:

1. Schedule training to provide Owner with at least **10** business days of notice in advance of training.
2. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session to be split in half with 15-minute break between sessions. Morning and afternoon sessions to be separated by 60-minute lunch period. Training, including breaks and excluding lunch period, are not to exceed eight hours per day.
3. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number, and email address.

2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
 3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
 4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
 5. At end of each training day, send Owner an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session. Indicate which attendees, if any, joined for only part of training sessions.
- E. Attendee Training Manuals:
1. Provide each attendee with color hard copy of all training materials and visual presentations.
 2. Organize hard-copy materials in three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
 3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes DVD or flash drive with PDF copy of all hard-copy materials.
- F. Organization of Training Sessions:
1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
 - a. Daily operators.
 - b. Advanced operators.
 - c. System managers and administrators.
 2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions to ensure DDC system security.
- G. Training Outline:
1. Submit training outline for Owner review at least ten business day before scheduling training.
 2. Include in outline a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session, and synopses for each lesson planned.
- H. On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
 2. Provide training materials, projector, and other audiovisual equipment used in training.
 3. Provide as much of training located on-site as deemed feasible and practical by Owner.
 4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
 5. Use operator workstation that is to be used with DDC system in the training. If operator workstations are unavailable, provide temporary workstation to convey training content.
- I. Training Content for Daily Operators:
1. Basic operation of system.
 2. Understanding DDC system architecture and configuration.
 3. Understanding each unique product type installed including performance and service requirements for each.
 4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm, and each unique optimization routine.
 5. Operating operator workstations, printers, and other peripherals.
 6. Logging on and off system.

7. Accessing graphics, reports, and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
 - a. Operation of HVAC equipment in normal-off, normal-on, and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
 - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
 - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles, and other modes of operation indicated.
 - d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
 - e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
 - f. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
 - g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

J. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting, and modifying alarms including annunciation and routing.
3. Creating, deleting, and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting, and modifying reports.
5. Creating, deleting, and modifying points.
6. Creating, deleting, and modifying programming including ability to edit control programs offline.
7. Creating, deleting, and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices, and I/O points.

14. Maintaining, calibrating, troubleshooting, diagnosing, and repairing hardware.
15. Adjusting, calibrating, and replacing DDC system components.

K. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading, and offline archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

L. Video of Training Sessions:

1. Provide digital video and audio recording of each training session. Create separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Owner with two copies of digital files on cloud and flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 230900

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Joining materials.
 - 4. Manual gas shutoff valves.
 - 5. Earthquake valves.
 - 6. Pressure regulators.
 - 7. Dielectric fittings.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.
- C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Piping specialties.
 - 2. Corrugated, stainless steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Shop Drawing Scale: 1/4 inch per foot.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Welding certificates.
- C. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

- D. Field quality-control reports.
- E. Qualification Statements: For professional engineer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For motorized gas valves pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide purging and startup of natural-gas supply in accordance with requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Construction Manager's written permission.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."
- C. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 220553 "Identification of Plumbing Piping and Equipment."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 54.
- B. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig minimum unless otherwise indicated.
- C. Natural-Gas System Pressure within Buildings:
 - 1. Single Pressure: 0.5 psig or less.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Seismic Performance: Natural-gas piping system is to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - 1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.0.

2.3 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 - 6. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Baker Hughes Company.
 - 2) Smith-Blair, a Xylem brand.
 - 3) .
 - b. Stainless steel flanges and tube with epoxy finish.
 - c. NBR seals.
 - d. Stainless steel bolts, washers, and nuts.
 - e. Coupling is to be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

- f. Steel body couplings installed underground on plastic pipe are to be factory equipped with anode.

2.4 PIPING SPECIALTIES

- A. Y-Pattern Strainers:
 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 3. Strainer Screen: 40 -mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
 4. CWP Rating: 125 psig.
- B. Weatherproof Vent Cap:
 1. Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.5 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.6 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 1. CWP Rating: 125 psig.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.
- B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 4. Service Mark: Initials "WOG" permanently marked on valve body.
 - a. A.Y. McDonald Mfg. Co.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. BrassCraft Manufacturing Co.; a Masco company.
 - d. Perfection Corporation.
 - e. R.W. Lyall; brand of Hubbell Utility Solutions; Hubbell Incorporated.

- f. .
 - 2. Body: Bronze, complying with ASTM B584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 - 8. CWP Rating: 600 psig.
 - 9. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Bronze Plug Valves: MSS SP-78.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Lee Brass Company.
 - c. .
 - 2. Body: Bronze, complying with ASTM B584.
 - 3. Plug: Bronze.
 - 4. Ends: Threaded, socket, or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 - 5. Operator: Square head or lug type with tamperproof feature where indicated.
 - 6. Pressure Class: 125 psig.
 - 7. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Flowserve Corporation.
 - c. Homestead Valve: a division of Olson Technologies, Inc.
 - d. Milliken Valve Company; a Mueller brand.
 - e. Mueller Co. LLC; Mueller Water Products, Inc.
 - f. R & M Energy Systems; Robbins & Myers.
 - g. .
 - 2. Body: Cast iron, complying with ASTM A126, Class B.
 - 3. Plug: Bronze or nickel-plated cast iron.
 - 4. Seat: Coated with thermoplastic.
 - 5. Stem Seal: Compatible with natural gas.
 - 6. Ends: Threaded or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
 - 7. Operator: Square head or lug type with tamperproof feature where indicated.
 - 8. Pressure Class: 125 psig.
 - 9. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Valve Boxes:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kerotest Manufacturing Corp.
 - b. Perfection Corporation.
 - c. R.W. Lyall; brand of Hubbell Utility Solutions; Hubbell Incorporated.

2. Cast-iron, two-section box.
3. Top section with cover with "GAS" lettering.
4. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
5. Adjustable cast-iron extensions of length required for depth of bury.
6. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.7 EARTHQUAKE VALVES

- A. Earthquake Valves, Maximum Operating Pressure of 5 psig: Comply with ASCE/SEI 25.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Firefighter Gas Safety Products.
 - b. Pacific Seismic Products, Inc.
 2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 3. Maximum Operating Pressure: 5 psig.
 4. Cast-aluminum body with nickel-plated chrome steel internal parts.
 5. NBR valve washer.
 6. Sight windows for visual indication of valve position.
 7. Threaded end connections complying with ASME B1.20.1.
 8. Wall-mounting bracket with bubble level indicator.

2.8 PRESSURE REGULATORS

- A. General Requirements:
1. Single stage and suitable for natural gas.
 2. Steel jacket and corrosion-resistant components.
 3. Elevation compensator.
 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Service Pressure Regulators: Comply with ANSI Z21.80A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Meter Company.
 - b. Fischer; Emerson Electric Co., Automation Solutions.
 - c. Schneider Electric USA, Inc.
 - d. .
 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: NBR; resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: UV-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
 9. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 100 psig.
 - a. Itron Inc.
 - b. Schneider Electric USA, Inc.

2.9 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- a. A.Y. McDonald Mfg. Co.
- B. Dielectric Flanges:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. GF Piping Systems: Georg Fischer LLC.
 - c. Matco-Norca.
 - d. WATTS; A Watts Water Technologies Company.
 - e. Wilkins.
 - f. .
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- C. Dielectric-Flange Insulating Kits:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CALPICO, Inc.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. GPT; a division of EnPRO Industries.
 - e. .
 - 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.10 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.
- B. Label and identify gas piping and pressure outside a multitenant building by tenant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping in accordance with NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for preventing accidental ignition.

3.3 INSTALLATION OF OUTDOOR PIPING

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 18 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 18 inches below finished grade, install it in containment conduit.
- C. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- D. Install fittings for changes in direction and branch connections.

3.4 INSTALLATION OF INDOOR PIPING

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Where installing piping above accessible ceilings, allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Verify final equipment locations for roughing-in.

- K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- M. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- N. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Containment conduit to terminate above grade within the building at both ends in accessible location.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- P. Connect branch piping from top or side of horizontal piping.
- Q. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- R. Do not use natural-gas piping as grounding electrode.
- S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.5 INSTALLATION OF VALVES

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install earthquake valves aboveground outside buildings according to listing.
- D. Do not install valves in return-air plenums.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, and then use wrench. Do not overtighten.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches of each fitting.
- F. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 PIPING CONNECTIONS

- A. Install natural-gas piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.
- B. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.
- C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.9 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

3.10 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas in accordance with NFPA 54 and authorities having jurisdiction.
 - 2. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports.

3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.12 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping is to be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping is to be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

- A. Aboveground, branch piping NPS 1 and smaller is to be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping is to be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping is to be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
 - 3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.14 ABOVEGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 and smaller are to be the following:
 - 1. Two-piece, full -port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

- B. Distribution piping valves for pipe sizes NPS 2-1/2 and larger are to be[one of] the following:
 - 1. Two-piece, full -port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, lubricated plug valve.

END OF SECTION 231123

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Steel pipe and fittings.
 - 3. Piping joining materials.
 - 4. Transition fittings.
 - 5. Dielectric fittings.

- B. Related Requirements:
 - 1. Section 013573 "Delegated Design Requirements and Procedures" for definitions, submittal procedures, responsibilities, and scheduling requirements associated with delegated design assignment indicated in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pipe and tube.
 - 2. Fittings.
 - 3. Joining materials.
 - 4. Transition fittings.

- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. Environmental Product Declaration: For each product.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

- B. Qualification Data: For Installer.

- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

- B. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

- C. Pipe Welding: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with ASME B31.9 for materials, products, and installation.

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.5 WARRANTY

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a registered design professional, as defined in Section 013573 "Delegated Design Requirements and Procedures" to design hydronic piping.
 1. Material properties indicated in this Section shall be considered as minimum properties.
- B. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 1. Hot-Water Heating Piping: **150** psig at 230 deg F.
 2. Chilled-Water and Energy Recovery Piping: 150 psig at 73 deg F 230Ftemperature.
 3. Dual-Temperature Heating- and Cooling-Water Piping: 100 psig at 180 deg F .
 4. Condenser-Water Piping: 150 psig at 73 deg F .
 - 5.
 6. Makeup-Water Piping: 150 psig at [150 deg F.
 7. Condensate-Drain Piping: 150 deg F .
 8. Air-Vent Piping: 200 deg F.
 9. Pressure-Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L.
- B. Annealed-Temper Copper Tube: ASTM B88, Type K.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
- D. Cast-Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 4.
- E. Wrought-Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.
- F. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Grinnell (Tyco International)
 - c. Star Pipe Products
 - d. Victaulic Company.
 - e. Or Equal..
 2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 582, bronze casting.
 3. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, peroxide cured EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
 4. Grooved, Mechanical-Joint, Copper Tube Appurtenances:
- G. Copper-Tube, Pressure-Seal-Joint Fittings - Copper or Bronze:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Grinnell (Tyco International).
 - b. NIBCO INC.
 - c. Viega LLC.
 - d. Or Equal.
2. Housing: Copper.
3. O-Rings and Pipe Stops: Peroxide cured EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200 psig working pressure rating at 250 deg F.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M black steel with plain ends; welded and seamless, Grade B, and schedule number as indicated in Part 3, "Piping Applications" Article.
- B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3, "Piping Applications" Article.
- C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3, "Piping Applications" Article.
- D. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- E. Wrought-Steel Fittings: ASTM A234/A234M; wall thickness to match adjoining pipe.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 1. Material Group: 1.1.
 2. End Connections: Butt welding.
 3. Facings: Raised face.
- G. Grooved Mechanical-Joint Fittings and Couplings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Grinnell (Tyco International).
 - b. Victaulic Company.
 - c. Star Pipe Products.
 - d. Or Equal.
 2. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 3. Couplings: Ductile- or malleable-iron housing and peroxide cured EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- H. Steel Pressure-Seal Fittings::
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company.
 - b. Or Equal.
 2. Housing: Steel.
 3. O-Rings and Pipe Stop: Peroxide cured EPDM.
 4. Sealing Mechanism: Manufacturer's special tool.
 5. Minimum Pressure Rating: 300-psig at 230 deg F.

- I. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Gasket Material: Thickness, material and type suitable for fluid to be handled and working temperatures and pressures.

2.5 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. HART Industrial Unions, LLC.
 - e. Jomar Valve.
 - f. Matco-Norca.
 - g. WATTS Regulator Co.
 - h. Wilkins.
 - i. Zurn Industries, LLC.
 - j. Matco-Norca.
 - k. Or Equal.
 - 2. Source Limitations: Obtain dielectric unions from single manufacturer.
 - 3. Description:

- a. Standard: ASSE 1079.
- b. Factory-fabricated, bolted, companion-flange assembly.
- c. Pressure Rating:150 psig.
- d. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. WATTS.
 - b. WATTS.
 - c. Wilkins.
 - d. Zurn Industries, LLC.
 - e. Or Equal.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating:150 psig.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Advance Products & Systems, LLC.
 - b. Calpico, Inc.
 - c. GF Piping Systems: Georg Fischer LLC.
 - d. Or Equal.
2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-Water Heating, Energy Recovery, and Chilled Water Piping, Aboveground, all sizes, to Be Any of the Following:
 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and [soldered][pressure-seal]joints.
 2. Schedule 40, Grade B, steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and threaded joints.
 3. Schedule 40 steel pipe; grooved mechanical joint coupling and fittings; and grooved mechanical joints.
 - a. Mechanical joints are limited to mechanical room and roof piping only.
 4. steel pressure-seal fittings; and pressure-seal joints.
- B. Makeup-Water Piping Installed Aboveground to Be Any of the Following:
 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- C. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:

1. Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Air-Vent Piping:

1. Inlet: Same as service where installed.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

E. Pressure-Relief-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- N. Install valves according to the following:
 1. Section 230523 "Valves for HVAC Piping."
- O. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- P. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- Q. Install shutoff valve immediately upstream of each dielectric fitting.
- R. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

- S. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- D. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- I. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric [flanges] [nipples].
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.g pipe.
- C. Install hangers for [**copper tubing**] [**and**] [**steel piping**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 7 feet.
 - 2. NPS 1: Maximum span, 7 feet.
 - 3. NPS 1-1/2: Maximum span, 9 feet.
 - 4. NPS 2: Maximum span, 10 feet.
 - 5. NPS 2-1/2: Maximum span, 11 feet.
 - 6. NPS 3 and Larger: Maximum span, 12 feet.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rodsizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- F. Support vertical runs at roof, at each floor and at 10-foot intervals between floors.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections are to be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gauges for HVAC Piping."

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.8 SYSTEM STARTUP

- A. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping in accordance with ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure is to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 5. Install pressure-relief valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
1. Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.

END OF SECTION 232113

SECTION 232113.13 - UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following underground hydronic piping:
 - 1. Preengineered cased piping system.

1.2 DEFINITIONS

- A. Invert: Vertical distance from Project datum reference point to bottom interior pipe surface.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Preengineered cased piping system components.
 - 2. Chemical treatment
- B. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.
 - 1. Include calculations showing requirements for expansion compensation for underground piping.
 - 2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement at required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
 - 3. Show pipe sizes, locations, inverts, and pitch. Show piping in trench, piping in conduit, and cased pipe with details showing clearances between piping.
 - 4. Show insulation thickness.
- C. Delegated-Design Submittal: For underground hydronic piping systems indicated to comply with performance requirements and design criteria, including analysis data and design drawings signed and sealed by the professional engineer responsible for their preparation.
 - 1. Include design calculations and details for selecting thermal expansion and thrust restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from hydronic distribution piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and at vertical scale of not less than 1 inch equals 5 feet.
 - 1. Show locations and inverts of utility system manholes and piping. Show manholes and piping. Show types, sizes, materials, and inverts of other utilities crossing hydronic piping.
 - 2. Show depth of cover from top of hydronic system pipes to finished grade.
- C. Qualification Data: For Installer.
- D. Welding certificates.
- E. Material Test Reports: For **[conduit] [cased]** piping, by a qualified testing agency.
- F. Source quality-control reports.

- G. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31.9, "Building Services Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services in accordance with requirements indicated:
 - 1. Notify Owner no fewer than four weeks in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without **[Architect's] [Construction Manager's] [Owner's]** written permission.

1.7 COORDINATION

- A. Coordinate pipe-fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
 - 1. Hot-Water Piping: 100 psig at 150 deg F.
 - 2. Chilled-Water Piping: 100 psig at 62.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design underground hydronic piping systems, including restraints and anchors.

2.2 PREENGINEERED CASED PIPING SYSTEM

- A. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thermacor Process, L.P.
 - b. Or equal.
 - 2. Source Limitations: Obtain piping system from single source from single manufacturer.
- B. Carrier Pipe: Materials as indicated in "Piping Application" Article. See articles in this Section for required carrier pipe material characteristics.
- C. Carrier Pipe Insulation:

1. Polyurethane Foam Pipe Insulation: Rigid, cellular, and high-pressure injected between carrier pipe and jacket.
 - a. Comply with ASTM C591; thermal conductivity (k-value) shall not exceed 0.165 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
- D. Casing: HDPE.
- E. Casing accessories include the following:
 1. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
- F. Manholes: Black steel with lifting eyes.
 1. Finish: Spray-applied urethane, minimum 30 mils thick.
 2. Access: 30-inch- diameter waterproof cover with gasket, ladder, and two 6-inch vents, one high and one low, extending above grade with rain caps.
 3. Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.
 4. Sump: 12 inches in diameter; 12 inches deep.
 5. Flotation Anchor: Oversized bottom keyed into concrete base.
- G. Cover: With polyurethane foam insulation with an HDPE jacket; thickness indicated in "Piping Application" Article.
- H. Source Quality Control: Factory test carrier pipe to 150 percent of operating pressure of system. Furnish test certificates.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATION

- A. Hot-Water Heating Piping:
 1. HDPE pipe and heat fusion butt-welded fittings; butt fusion welded joints.
 2. Cased Piping: Polyurethane carrier-pipe insulation.
 - a. Piping Insulation Thickness: 2 inches.
- B. Chilled-Water Piping:
 1. HDPE pipe and heat fusion butt-welded fittings; butt fusion welded joints.
 2. Cased Piping: Polyurethane carrier-pipe insulation.
 - a. Piping Insulation Thickness: 2 inches.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Remove standing water in the bottom of trench.
- C. Bed the pipe on a minimum 6-inch layer of pipe system manufacturer's recommended granular fill material with a minimum 6-inch clearance between pipes.

- D. Do not backfill piping trench until field quality-control testing has been completed and results approved.
- E. Install components with pressure rating equal to or greater than system operating pressure.
- F. Install piping in straight lines. Do not bend pipe.
- G. Install fittings for changes in direction and branch connections.
- H. See Section 230517 "Sleeves and Sleeve Seals for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.
- I. Connect to hydronic piping where it passes through the building wall. Hydronic piping inside the building is specified in Section 232113 "Hydronic Piping."
- J. After field quality-control testing is complete, backfill with 6 inches (150 mm) of clean, granular material in accordance with piping system manufacturer's written instructions. If mechanical compaction is required, manually backfill to 12 inches (300 mm) before using mechanical-compaction equipment.
- K. See Section 230523 "General Duty Valves for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.
- L. Secure anchors and fittings where piping changes direction, and where elsewhere required by manufacturer's written installation instructions, with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- M. See Section 134713 "Cathodic Protection" for cathodic devices and connections to piping and conduit systems.
- N. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. See Section 033000 "Cast-in-Place Concrete" for concrete and reinforcement.
- O. After field quality-control testing is complete, backfill with 6 inches of clean, granular material in accordance with piping system manufacturer's written instructions. If mechanical compaction is required, manually backfill to 12 inches before using mechanical-compaction equipment.

3.4 JOINT CONSTRUCTION

- A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. Join pipe and fittings in accordance with the following requirements and Section 232113 "Hydronic Piping":
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators, in accordance with "Quality Assurance" Article.
- D. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation and exterior jacket sleeve, and apply shrink-wrap seals.

3.5 IDENTIFICATION

- A. Install continuous plastic underground warning tapes during backfilling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 312000 "Earth Moving" for warning-tape materials and devices and their installation.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor to engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Prepare hydronic piping for testing in accordance with ASME B31.9 and as follows:
 - a. Leave joints, including welds, uninsulated and exposed for examination during test.
 - b. Isolate equipment and instrumentation. Do not subject equipment and instrumentation to test pressure.
 - c. Install relief valve set to relieve at pressure no more than one-third higher than test pressure.
 - d. Fill system with water. Where there is risk of freezing, perform testing with air or liquid that will not freeze or cause damage to piping system materials.
 - e. For hydrostatic testing, install vents at high points to release trapped air while filling system. Remove test liquid at accessible low points.
 - 2. Test hydronic piping as follows:
 - a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times system design pressure.
 - b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
 - c. Do not pressurize carrier pipe with air.
 - d. Maintain test pressure for **[two] [four] <Insert number>** hours with no loss of pressure.
 - 3. Test conduit as follows:
 - a. Seal vents and drains and subject conduit to 15-psig compressed air for four hours with no loss of pressure. Repair leaks and retest.
- C. Prepare test and inspection reports.
- D. When successful testing is complete, flush carrier piping to remove dirt or debris remaining after construction. Drain piping after flushing is complete.
- E. Fill underground piping system with permanent system liquid prior to system testing and balancing.

END OF SECTION 232113.13

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Hydronic specialty valves.
 - 2. Air vents.
 - 3. Expansion tanks and fittings.
 - 4. Air separators.
 - 5. Strainers.
 - 6. Flexible connectors.

- B. Related Requirements:
 - 1. Section 230523 "General-Duty Valves for HVAC Piping" for specification and installation requirements for general-duty valves common to most piping systems.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product:
 - 1. Include construction details and material descriptions for hydronic piping specialties.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators in accordance with ASME BPVC, Section IX.

- B. Pressure-relief and safety-relief valves and pressure vessels bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC, Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

- A. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Fluid Technology.
 - b. Bell & Gossett; a Xylem brand.
 - c. Griswold Controls, LLC.

- d. Or equal.
 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 3. Ball: Brass or stainless steel.
 4. Plug: Resin.
 5. Seat: PTFE.
 6. End Connections: Threaded or socket.
 7. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
 8. Handle Style: Lever, with memory stop to retain set position.
 9. CWP Rating: Minimum 125 psig.
 10. Maximum Operating Temperature: 250 deg F.
- B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Fluid Technology.
 - b. Bell & Gossett; a Xylem brand.
 - c. Griswold Controls, LLC.
 - d. Or equal.
 2. Body: Cast-iron or steel body, ball, butterfly, plug, or globe pattern with calibrated orifice or venturi.
 3. Ball: Brass or stainless steel.
 4. Stem Seals: EPDM O-rings.
 5. Disc: Glass- and carbon-filled PTFE.
 6. Seat: PTFE.
 7. End Connections: Flanged or grooved.
 8. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
 9. Handle Style: Lever, with memory stop to retain set position.
 10. CWP Rating: Minimum 125 psig.
 11. Maximum Operating Temperature: 250 deg F.
- C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol
 - b. Armstrong Pumps
 - c. Bell & Gossett; a Xylem brand.
 - d. Or equal.
 2. Body: Bronze or brass.
 3. Disc: Glass and carbon-filled PTFE
 4. Seat: Brass.
 5. Stem Seals: EPDM O-rings.
 6. Diaphragm: EPT.
 7. Low inlet-pressure check valve.
 8. Inlet Strainer: stainless steel, removable without system shutdown.
 9. Valve Seat and Stem: Noncorrosive.
 10. Valve Size and Capacity: As indicated on Drawings.
 11. Operating Pressure: Factory set and field adjustable.

2.2 AIR VENTS

- A. Manual Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol
 - b. Armstrong Pumps
 - c. Bell & Gossett; a Xylem brand.
 - d. Or equal.
 2. Body: Bronze.

3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol
 - b. Armstrong Pumps
 - c. Bell & Gossett; a Xylem brand.
 - d. Or equal.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

2.3 EXPANSION TANKS AND FITTINGS

A. Bladder-Type ASME Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Wessels
 - b. Armstrong Fluid Technology.
 - c. Bell & Gossett; a Xylem brand.
 - d. Or equal.
2. Tank: Welded steel, rated for 125 psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.4 AIR SEPARATORS

A. In-Line Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Fluid Technology.
 - b. Bell & Gossett; a Xylem brand.
 - c. Spirotherm, Inc.
 - d. Or equal.
2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
3. Maximum Working Pressure: Up to 175 psig.
4. Maximum Operating Temperature: Up to 300 deg F.

2.5 STRAINERS

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Griswold Controls, LLC.
- b. Victaulic Company.
- c. WATTS; A Watts Water Technologies Company.
2. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: Stainless steel, 40 -mesh strainer, or perforated stainless steel basket.
5. CWP Rating: 125 psig.

2.6 FLEXIBLE CONNECTORS

A. Stainless Steel Bellows, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Flo Fab Inc.
 - c. Metraflex Company (The).
 - d. Or equal.
2. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

B. Spherical, Rubber, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flexicraft Industries.
 - b. Flo Fab Inc.
 - c. Metraflex Company (The).
 - d. Or equal.
2. Body: Fiber-reinforced rubber body.
3. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
4. Performance: Capable of misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine all piping specialties for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Examine threads on all devices for form and cleanliness.
- C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.2 INSTALLATION OF VALVES

- A. Install calibrated-orifice balancing valve at each branch connection to return main.

- B. Install calibrated-orifice, balancing valve in the return pipe of each heating or cooling terminal.

3.3 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.
 - 1. Provide air outlet drain line full size of air outlet to floor drain or to other point indicated on Drawings.
- C. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- E. Install diaphragm- or bladder-type expansion tanks on the floor.
- F. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Close-coupled, in-line centrifugal pumps.
 - 2.

1.2 DEFINITIONS

- A. ECM: Electronically commutated motor.
- B. EPDM: Ethylene propylene diene monomer.
- C. EPR: Ethylene propylene rubber.
- D. FKM: Fluoroelastomer polymer.
- E. HI: Hydraulic Institute.
- F. NBR: Nitrile rubber or Buna-N.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pump.
 - 1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
 - 2. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: **One** mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bell and Gossett
 2. Armstrong Fluid Technology.
 3. PACO Pumps; Grundfos Pumps Corporation, USA.
- B. Source Limitations: Obtain pumps from single source from single manufacturer.
- C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
- D. Pump Construction:
 1. Casing: Radially split, cast iron, with threaded gauge tapings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange union-end connections.
 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
 3. Pump Shaft Sleeve: Type 304 stainless steel.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM rubber bellows and gasket. Include water slinger on shaft between motor and seal.
 5. Seal Flushing: Flush, cool, and lubricate pump seal by directing pump discharge water to flow over the seal.
- E. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513
 1. Provide integral pump motor variable-speed controller.

2.3

- 1.
- B.
 - 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with **HI 1.4 and HI 2.4**.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Equipment Mounting:
 - 1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 ALIGNMENT

- A. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.
- B. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- F. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

3.5 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping. Use startup strainer for initial startup.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.
- B. Provide 8 hours of training to Owner. Provide 20 workdays of notice to the Owner and conduct a maximum of 4 hours of classroom training and the balance in the field. Classroom training shall be local to the Bay Area or conducted at Las Positas College.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Copper tube and fittings.
 2. Refrigerants.

1.2 ACTION SUBMITTALS

- A. Product Data Submittals: For each product.
1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.
 2. For refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- B. Sustainable Design Submittals:
1. Refrigerant: Product Data for refrigerants, indicating compliance with refrigerant management practices.
- C. Shop Drawings:
1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 2. Show interface and spatial relationships between piping and equipment.
 3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding Certificates: For each welder performing shop or field welding on Project.
- B. Field Quality-Control Reports: For each field quality control test and inspection.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.
- B. Prepare valves and specialties for shipping as follows:
1. Protect internal parts against rust and corrosion.

2. Protect threads and other end connections.
- C. Use the following precautions during storage:
 1. Maintain valve and specialty end protection.
 2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A.
- B. Comply with ASHRAE 15.
- C. Comply with ASME B31.5.
- D. Test Pressure for Refrigerant R-454b:
 1. Suction Tubing Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 115 psig.
 2. Suction Tubing for Heat-Pump Applications: 225 psig.
 3. Hot-Gas and Liquid Tubing: 225 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B280, Type ACR.
- B. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals: AWS A5.8M/A5.8.
- E. Flexible Connectors:
 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 2. End Connections: Socket ends.
 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
 4. Working Pressure Rating: Factory test at minimum 500 psig .
 5. Maximum Operating Temperature: 250 deg F.
- F. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Mueller Streamline Co.; a company of Mueller Industries.
 - b. Parker Hannifin; Sporlan Division (Zoomlock).

2.3 REFRIGERANTS

- A. R-454b, ASHRAE 34:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arkema Inc.
 - b. DuPont Fluorochemicals Div.
 - c. Genetron Refrigerants; Honeywell International Inc.

- d. Mexichem Fluor, Inc. (Koura).
- e. Or equal.

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

- A. Refrigerant: R454b
- B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- C.
- D.

3.2 INSTALLATION OF PIPING, GENERAL

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping in accordance with ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in rigid conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 2. Install horizontal suction lines with a uniform slope downward to compressor.
 3. Install traps and double risers to entrain oil in vertical runs.
 4. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors.
- S. Install sleeve seals for piping penetrations of concrete walls and slabs.
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Brazed Joints: Construct joints in accordance with AWS BRH, "Braze Handbook," Ch. 35, "Pipe and Tubing."
1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft. long.
 2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches of each fitting.

- F. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System must maintain test pressure at the manifold gauge throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.6 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

END OF SECTION 232300

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Water treatment for closed-loop hydronic systems.
 - 2. Manual chemical-feed equipment.
 - 3. Automatic chemical-feed equipment.
 - 4. Chemicals.

1.2 DEFINITIONS

- A. RO: Reverse osmosis.
- B. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.
- C. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
 - 1. Bypass feeders.
 - 2. Water meters.
 - 3. Inhibitor injection timers.
 - 4. pH controllers.
 - 5. Chemical solution tanks.
 - 6. Injection pumps.
 - 7. Chemical-treatment test equipment.
 - 8. Chemical material safety data sheets.
- B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to hydronic systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- C. Field quality-control reports.

- D. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
- E. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Aqua-Chem, Inc.
 - 2. Nalco; an Ecolab company.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Project is connecting to an existing Central Utility Plant (CUP). Chemical treatment and water quality shall match the water quality of the CUP water systems prior to opening the B1500 to the CUP distribution loop.
- D. Closed hydronic systems, including hot-water heating below 250 deg F, chilled water , and Energy Recovery Water shall have the following water qualities:
 - 1. pH: Balance to CUP distribution loop criteria.
 - 2. Alkalinity: Balance to CUP distribution loop criteria.
 - 3. Steel Corrosion Inhibitors: Balance to CUP distribution loop criteria.
 - 4. Yellow Metal Corrosion Inhibitor: Balance to CUP distribution loop criteria.
 - 5. Scale Control: Balance to CUP distribution loop criteria.
 - 6. Dispersants: Balance to CUP distribution loop criteria.
 - 7. Microbiological Limits:
 - a. Total Aerobic Plate Count: Balance to CUP distribution loop criteria.
 - b. Total Anaerobic Plate Count: Balance to CUP distribution loop criteria.
 - c. Nitrate Reducers: Balance to CUP distribution loop criteria.
 - d. Sulfate Reducers: Balance to CUP distribution loop criteria.
 - e. Iron Bacteria: Balance to CUP distribution loop criteria.
 - 8.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Provide steel feeders with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Provide quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: Sized to system requirements.
 2. Minimum Working Pressure: 125 psig.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

- A. Water Meter, Turbine Type, Flanged:
1. AWWA C701, turbine-type, totalization meter.
 2. Body: Epoxy-coated cast iron.
 3. Minimum Working-Pressure Rating: 150 psig.
 4. Maximum Pressure Loss at Design Flow: 3 psig.
 5. Registration: Gallons or cubic feet.
 6. End Connections: Flanged.
 7. Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.
 8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Chemical Solution Tanks:
1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
 2. Molded cover with recess for mounting pump.
 3. Capacity: Sized to system requirements.
- C. Chemical Solution Injection Pumps:
1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
 2. Adjustable flow rate.
 3. Metal and thermoplastic construction.
 4. Built-in relief valve.
- D. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A269/A269M, Type 304 stainless steel for systems exposed to ambient (roof top) conditions.
- E. Injection Assembly:
1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
 2. Ball Valve: Three Two-piece, stainless steel; selected to fit quill.
 3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
 4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.5 CHEMICAL-TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, corrosion inhibitors, alkalinity, hardness, and other properties recommended by manufacturer.

2.6 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.
 - 1. Houghton Chemical Corp.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.
- B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install water-testing equipment on wall near water-chemical-application equipment.
- D. Install interconnecting control wiring for chemical-treatment controls and sensors.
- E. Mount sensors and injectors in piping circuits.
- F. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, chilled water,, and Energy Recovery Water, and equip with the following:
 - 1. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
 - 2. Install water meter in makeup-water supply.
 - 3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
 - 4. Install a full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
 - 5. Install a swing check on the inlet after the isolation valve.

3.3 PIPING CONNECTIONS

- A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."

- E. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in make-up-water connections to potable-water systems.

3.4 ELECTRICAL CONNECTIONS

- A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency:
 - 1. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 - 8. Repair leaks and defects with new materials, and retest piping until no leaks exist.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. At four -week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- F. Comply with ASTM D3370 and with the following standards:
 - 1. Silica: ASTM D859.
 - 2. Acidity and Alkalinity: ASTM D1067.
 - 3. Iron: ASTM D1068.
 - 4. Water Hardness: ASTM D1126.

3.6 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
 3. Periodic field service and consultation.
 4. Customer report charts and log sheets.
 5. Laboratory technical analysis.
 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Provide up to 2 hours of classroom training in the Bay Area or at Las Positas and 4 hours of on site training.

END OF SECTION 232513

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Single-wall rectangular ducts and fittings.
 2. Single-wall round ducts and fittings.
 3. Sheet metal materials.
 4. Duct liner.
 5. Sealants and gaskets.
 6. Hangers and supports.
- B. Related Requirements:
1. Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint devices and installation.
 2. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
 4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
1. Liners and adhesives.
 2. Sealants and gaskets.
 3. Seismic-restraint devices.
- B. Sustainable Design Submittals:
1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 3. Product Data: For adhesives, indicating VOC content.
 4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 5. Product Data: For sealants, indicating VOC content.
 6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
 7. Laboratory Test Reports: For antimicrobial coatings, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 2. Factory- and shop-fabricated ducts and fittings.
 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 4. Elevation of top and bottom of ducts.
 5. Dimensions of main duct runs from building grid lines.
 6. Fittings.
 7. Sheet metal thicknesses.
 8. Reinforcement details and spacing.

9. Seam and joint construction and sealing.
10. Penetrations through fire-rated and other partitions.
11. Equipment installation based on equipment being used on Project.
12. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
13. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Welding certificates.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Duct Construction: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Duct Hangers and Supports: Duct hangers and supports and seismic restraints are to withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- C. Seismic: Ductwork to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified ."
 2. Component Importance Factor: 1.0.
- D. Wind : Ducts are to withstand the effects of wind determined in accordance with to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."
- E. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- H. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 - 2. For ducts exposed to weather and as noted in drawings, construct of Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 - 2. For ducts exposed to weather and as noted in drawings, construct of Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.
- B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.
- D. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- E. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch- minimum diameter for lengths longer than 36 inches.

2.5 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. Ductmate Industries, Inc.
 - d. K-Flex USA.
 - e. Or equal
 - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 - 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. Adhesive shall have a VOC content of 80 g/L or less.
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Fibrous-Glass-Free, Natural-Fiber Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acoustical Surfaces, Inc.
 - b. Bonded Logic
 - c. Ductmate Industries, Inc.
 - d. Or equal
 - 2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
 - 3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
 - 4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

- a. Adhesive shall have a VOC content of 80 g/L or less.
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel aluminum stainless steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
 9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
 10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.

5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Solvent-Based Joint and Seam Sealant:

1. Sealant shall have a VOC content of 420 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- M. Elbows: Use long-radius elbows wherever they fit.
 - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
 - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.
- N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCTWORK EXPOSED TO WEATHER AND AS NOTED IN DRAWINGS

- A. All external joints are to be welded. Seal all openings to provide weatherproof construction.
- B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.
- C. Single Wall:
 - 1. Ductwork is to be Type 316 stainless steel.
 - 2. Ductwork is to be galvanized steel.
 - a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099113 "Exterior Painting."
 - 3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.

- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint installation requirements.

3.7 DUCTWORK CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Supply Ducts with a Pressure Class Equal or Higher Than 3-Inch wg: Test 100 percent of total installed duct area for each designated pressure class.
 - b. Supply Ducts with a Pressure Class less than 3 Inch wg : Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - c. Exhaust Ducts with a Pressure Class of -4 Inch wg or lower: Test 100 percent of total installed duct area for each designated pressure class.
 - d. Exhaust Ducts with a Pressure Class less than -4 Inch wg : Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
 - 5. Test for leaks before applying external insulation.
 - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 7. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.10 STARTUP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
 2. Liner:
 - a. Transfer Air Ducts: Fibrous-Glass-Free, Natural-Fiber Duct Liner, 1 inch thick.
 3. Duct Material:
 - a. All ductwork shall be galvanized sheet metal, except for:
 - 1) All ductwork on the roof unless insulated, shall be welded stainless steel duct.
 - 2) Exhaust air from chemical fume hood and as noted on drawings to point of dilution, shall be welded stainless steel duct.
 4. Canopy hood and exhaust air from canopy hood to point of dilution, shall be welded stainless steel duct.

END OF SECTION 233113

SECTION 233119 - HVAC CASINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Factory -fabricated, field-assembled, double -wall casings for HVAC plenums.

1.2 PERFORMANCE REQUIREMENTS

- A. Static-Pressure Classes:
1. Exhaust Air Plenum: -6 -inch wg.
 2. .
- B. Structural Performance:
1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot of width.
 - a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft.
- C. Seismic Performance: HVAC casings shall withstand the effects of earthquake motions determined according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7 .
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
1. Factory-fabricated casings.
 2. Liners and adhesives.
 3. Sealants and gaskets.
 4. Seismic-restraint devices.
- B. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.
1. Detail HVAC casing assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Sheet metal thickness(es).
 3. Reinforcement and spacing.
 4. Seam and joint construction.
 - 5.
 6. Locations for access to internal components.
 7. Hangers and supports including methods for building attachment, vibration isolation seismic restraints, and casing attachment.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.6 COORDINATION

- A.
- B. Coordinate sizes and locations of steel supports. Supports are specified in Section 055000 "Metal Fabrications."
- C.

PART 2 - PRODUCTS

2.1 GENERAL CASING FABRICATION REQUIREMENTS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 9, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
 - 1. Fabricate casings with more than 3-inch wg negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
 - 2. Casings with more than 2-inch wg positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Exterior Surface Galvanized Coating Designation: G90.
 - 2. Interior Surface Galvanized Coating Designation: G90 (Z275).
 - a.
- C. Stainless Steel: ASTM A 480/A 480M, Type 316, and having a No. 2D finish.
- D. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.
- E. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

2.2 MANUFACTURED CASINGS

- A. Description: Double-wall, insulated, pressurized casing.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Industrial Noise Control, Inc.
 - 2. McGill AirSilence LLC.
 - 3. SEMCO Incorporated.
 - 4. Vibro-Acoustics.
 - 5. .

- 6.
- 7.
- 8.

C. Exhaust Air Plenum:

1. Double-Wall Panel Fabrication: Solid, galvanized sheet steel exterior wall and perforated, galvanized sheet steel interior wall.
2. Wall Thickness: 2 inches.
3. Fabricate with a minimum number of joints.
4. Weld exterior and interior walls to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
5. Sheet metal thickness shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for static-pressure class indicated for casing.
6. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.
7. Fabricate panels with continuous tongue-and-groove and self-locking joints effective inside and outside each panel.
- 8.

D. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.

2.3

A.

1. :
 - a.
2.
 - a.
 - b.

2.4 SEALANT MATERIALS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine steel supports for compliance with requirements for conditions affecting installation and performance of HVAC casings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Install seismic restraints on casings. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Apply sealant to joints, connections, and mountings.
- D. Factory or field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Support casings on floor or foundation system. Secure and seal to base.
- F. Support components rigidly with ties, braces, brackets, seismic restraints, and anchors of types that will maintain housing shape and prevent buckling.
- G. Align casings accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."
 - 2. Test the following systems:
 - a. Systems required by ASHRAE/IESNA 90.1.
 - 3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 4. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.
 - 5. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- B. HVAC casings will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 CLEANING

- A. Comply with requirements for cleaning in Section 233113 "Metal Ducts."

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Backdraft and pressure relief dampers.
 2. Manual volume dampers.
 3. Control dampers.
 4. Combination fire and smoke dampers.
 5. Flange connectors.
 6. Duct silencers.
 7. Turning vanes.
 8. Duct-mounted access doors.
 9. Flexible connectors.
 10. Duct accessory hardware.
- B. Related Requirements:
1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.
 2. Section 284621.11 "Addressable Fire-Alarm Systems" for duct-mounted fire and smoke detectors.
 3. Section 284621.13 "Conventional Fire-Alarm Systems" for duct-mounted fire and smoke detectors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations .
- B. Sustainable Design Submittals:
1. Product data showing compliance with ASHRAE 62.1.
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.
- B. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Nailor Industries Inc.
 - 2. Pottorff.
 - 3. Ruskin Company.
 - 4. Or equal.
- B. Description: Gravity balanced.
- C. Performance:
 - 1. Maximum Air Velocity: 3000 fpm.
 - 2. Maximum System Pressure: 6 inches wg.
- D. Construction:
 - 1. Frame: 3 inches x 20 gage galvanized sheet steel shaped channel, with welded corners or
 - a. mechanically attached and mounting flange.
 - 2. Blades:
 - a. Multiple single-piece blades.
 - b. Center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.
 - 3. Blade Action: Parallel.
- E. Blade Seals: Extruded vinyl, mechanically locked.
- F. Blade Axles:
 - 1. Material: Synthetic mechanically locked to the blade.
 - 2. Diameter: 0.20 inch.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Return Spring: Adjustable tension.
- I. Bearings: Corrosion resistant synthetic bearings formed as a single piece to the axle.
- J. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Chain pulls.
4. Screen Mounting:
 - a. Front mounted in sleeve.
 - 1) Sleeve Thickness: 20 gauge minimum.
 - 2) Sleeve Length: 6 inches minimum.
5. Screen Material: Galvanized steel Aluminum.
6. Screen Type: Bird Insect.
7. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. Nailor Industries Inc.
 - c. Ruskin Company.
 - d. Or equal.
2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
4. Frames:
 - a. Hat-shaped, 0.094-inch- thick, galvanized sheet steel or 0.05-inch- thick stainless
 - b. steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel; 16 gauge thick.
6. Blade Axles: Galvanized steel metal.
7. Bearings:
 - a. Oil-impregnated bronze Molded synthetic Oil-impregnated stainless steel sleeve Stainless steel sleeve.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
8. Tie Bars and Brackets: Galvanized steel.

B. Standard, Stainless Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. Nailor Industries Inc.
 - c. Ruskin Company.
2. Performance:

- a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. (203 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
 3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 4. Frames:
 - a. Hat-shaped, 0.094-inch- thick, galvanized sheet steel or 0.05-inch- thick stainless steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized Stainless steel; 16 gauge thick.
 6. Blade Axles: Stainless steel metal,
 7. Bearings:
 - a. Oil-impregnated bronze Molded synthetic Oil-impregnated stainless steel sleeve Stainless steel sleeve.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 8. Tie Bars and Brackets: Stainless steel.
- C. Standard, Aluminum, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. Nailor Industries Inc.
 - c. Ruskin Company.
 - d. Or equal.
 2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
 3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 4. Frames:
 - a. Hat-shaped, 0.10-inch- thick, aluminum sheet channels.
 - b. Flanges for attaching to walls and flangeless frames for installing in ducts.
 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d.
 - e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Axles: Galvanized steel metal.
 7. Bearings:
 - a. Oil-impregnated bronze Molded synthetic Stainless steel sleeve.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 8. Tie Bars and Brackets: Aluminum.

- D. Jackshaft:
 - 1. Size: 0.5-inch 1-inch diameter.
 - 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

- E. Damper Hardware:
 - 1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - 2. Include center hole to suit damper operating-rod size.
 - 3. Include elevated platform for insulated duct mounting.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Ruskin Company.
 - 3. Nailor
 - 4. Or equal.

- B. General Requirements:
 - 1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.

- C. Fire Rating: Refer to architectural plans

- D. Performance:
 - 1. Leakage:
 - a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
 - 2. Rated pressure and velocity to exceed design airflow conditions.

- E. Construction:
 - 1. Suitable for horizontal or vertical airflow applications.
 - 2. Linkage out of airstream.
 - 3. Frame:
 - a. Hat shaped.
 - b. 0.094-inch- thick Galvanized sheet steel, with welded interlocking, gusseted mechanically attached corners and mounting flange.
 - c. Gauge is to be in accordance with UL listing.
 - 4. Blades:
 - a. Roll-formed, horizontal, v-groove airfoil, galvanized sheet steel stainless steel extruded aluminum.
 - b. Maximum width and gauge in accordance with UL listing.
 - 5. Blade Edging Seals:
 - a. Silicone rubber.
 - 6. Blade Jamb Seal: Flexible stainless steel, compression type.
 - 7. Blade Axles: 1/2-inch- diameter; galvanized steel stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of airstream.
 - 8. Bearings:

- a. Oil-impregnated bronze Molded synthetic Oil-impregnated stainless steel sleeve Stainless steel sleeve.
- F. Mounting Sleeve:
 - 1. Factory installed, galvanized sheet steel.
 - 2. Length to suit wall or floor application[**with factory-furnished silicone caulking**].
 - 3. Gauge in accordance with UL listing.
- G. Heat-Responsive Device:
 - 1. Replaceable, 165 deg F rated, fusible links.
 - 2. Electric resettable link device and switch package, factory installed, rated.
- H. Master control panel for use in dynamic smoke-management systems.
- I. Damper Motors: Two-position action.
- J. Accessories:
 - 1. Auxiliary switches for signaling fan control position indication.
 - 2. Test and reset switches, remote mounted.
 - 3. Smoke Detector: Integral, factory wired for single-point connection.

2.5 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CL WARD & Family Inc.
 - 2. Ductmate Industries, Inc.
 - 3. Hardcast
 - 4. Or equal.
- B. Description: Add-on roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gauge and Shape: Match connecting ductwork.

2.6 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. IAC Acoustics; a division of Sound Seal.
 - 2.
 - 3. Ruskin Company.
 - 4. Vibro-Acoustics.
 - 5. Insert manufacturer's name.
- B. General Requirements:
 - 1. Factory fabricated.
 - 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.

- C. Shape:
1. Rectangular straight with splitters or baffles.
 2. Round straight with center bodies or pods.
 3. Rectangular elbow with splitters or baffles.
 4. Round elbow with center bodies or pods.
 5. Rectangular transitional with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90 G60, galvanized sheet steel, 0.034 inch 0.040 inch thick.
- E. Round Silencer Outer Casing: ASTM A653/A653M, G90 G60, galvanized sheet steel.
1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 22 gauge thick.
 2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 20 gauge thick.
 3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 18 gauge thick.
 4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 16 gauge thick.
- F. Inner Casing and Baffles: ASTM A653/A653M, G90 G60 galvanized sheet metal, 22 gauge thick, and with 1/8-inch- diameter perforations.
- G. Special Construction:
1. Suitable for outdoor use.
 2. High transmission loss to achieve STC 45.
- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- I. Principal Sound-Absorbing Mechanism:
1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 2. Dissipative Film-lined type with fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression Inert and vermin-proof fibrous material, packed under not less than 15 percent compression Moisture-proof nonfibrous material.
 - b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.
 3. Lining: None Mylar Tedlar Fiberglas cloth Insert material.
- J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. Joints: Lock formed and sealed Continuously welded flanged connections.
 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- K. Accessories:
1. Factory-installed end caps to prevent contamination during shipping.
- L. Source Quality Control:
1. Test in accordance with ASTM E477.
 2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000 fpm face velocity.
 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.
- M. Capacities and Characteristics:

1. Configuration: Straight.
2. Shape: Rectangular.
3. Attenuation Mechanism: Acoustical glass fiber with protective film liner.
4. Maximum Pressure Drop: 0.35 inch wg.
5. Casing:
 - a. Attenuation: Standard.
 - b. Outer Material: Galvanized steel.
 - c. Inner Material: Galvanized steel.
- 6.
7. End Connection: Flange.
8.
 - a.
- 9.

2.7 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. SEMCO
 4. Or equal.
- B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. Vane Construction:
 1. For duct systems less than or equal to 2" w.g. static pressure, provide single wall vanes
 2. For duct systems greater than 2" w.g., provide double walled turning vanes.
- E. Provide turning vanes on 90 degree and 45 degree elbows as noted on plans.

2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Greenheck
 2. McGill AirFlow LLC.
 3. Nailor
 4. Or equal.
- B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.

- d. Fabricate doors airtight and suitable for duct pressure class.
- 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches].
 - d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

C.

2.9 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Duro Dyne Inc.
 - 2. Elgen Manufacturing.
 - 3. Ventfabrics, Inc.
 - 4. Or equal.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Materials: Flame-retardant or noncombustible fabrics.
- D. Coatings and Adhesives: Comply with UL 181, Class 1.
- E. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- G. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.

2.10 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
- H. Install combination fire and smokedampers in accordance with UL listing.
- I. Connect ducts to duct silencers rigidly.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
- K. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 18 inches.
 - 4. Head and Shoulders Access: 21 by 21 inches.
 - 5. Body Access: 25 by 25 inches.
 - 6. Body plus Ladder Access: 25 by 25 inches.
- L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Install duct test holes where required for testing and balancing purposes.
- P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
 - 3. Operate combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Acoustic rated flexible ducts
 - 2. Flexible duct connectors.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Acoustic rated flexible ducts
 - 2. Flexible duct connectors.
- B. Product Data Submittals: For each type of product.
- C. Sustainable Design Submittals:
 - 1. Product data showing compliance with ASHRAE 62.1.
 - 2. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.
- D. Shop Drawings: For flexible ducts.
 - 1. Include plans showing locations, mounting details, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with the Air Duct Council's (formerly, Air Diffusion Council) "ADC Flexible Air Duct Test Code - FD 72-R1" and "Flexible Duct Performance & Installation Standards."
- D. Comply with ASTM E96/E96M.

2.2 ACOUSTICAL FLEXIBLE DUCT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Casco Silent Flex II
 - 2. Genflex IL

3. Cody West NILS
4. Or equal.

- B. Construction: Min R-6 or per California Energy Code
- C. Liner: Spunbonded nonwoven nylon with porous surface for max sound absorption
- D. Helix: high carbon, spring steel wire.
- E. Jacketing: Metalized polyester sleeve (UL rated)
- F. Class 1, UL 723 rated. UL listed for Class 1 air duct in accordance with Standard 181.
- G. Operating pressure: -1/2 in w g to 2" wg on all diameters.

2.3 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless steel band with stainless steel or zinc-plated hex screw to tighten band with a worm-gear action Nylon strap in sizes 3 through 18 inches, to suit duct size.
- B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION OF FLEXIBLE DUCTS

- A. Install flexible ducts in accordance with applicable details in the following publications:
 1. NAIMA AH116.
 2. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install in indoor applications only. Do not install flexible duct in locations where it will be exposed to UV lighting.
- C. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- D. Installation:
 1. Install ducts fully extended.
 2. Do not bend ducts across sharp corners.
 3. Bends of flexible ducting must not exceed a minimum of one-duct diameter.
 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 5. Install flexible ducts in a direct line, without sags, twists, or turns.
 6. Install in accordance with ADC instructions.
- E. Supporting Flexible Ducts:
 1. Support flexible duct at manufacturer's recommended intervals, but at no greater distance than 4 ft.. Provide sufficient support so that maximum centerline sag is 1/2 in. per ft. between supports. A connection to rigid duct or equipment may be considered a support joint.
 2. Install extra supports at bends placed approximately one-duct diameter from center line of the bend.
 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports must not exceed the maximum spacing in accordance with manufacturer's written installation instructions.
 4. Vertically installed ducts must be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

SECTION 233400 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Fans, centrifugal - backward-inclined blades.
 2. Fans, utility set.

1.2 ACTION SUBMITTALS

- A. Product Data:
1. For each type of product.
 - a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - b. Rated capacities, furnished specialties, and accessories for each fan.
 - c. Fans:
 - 1) Certified fan performance curves with system operating conditions indicated.
 - 2) Certified fan sound-power ratings.
 - 3) Fan construction and accessories.
 - 4) Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 5) Fan speed controllers.
 - d. Material thickness and finishes, including color charts.
 - e. Dampers, including housings, linkages, and operators.
- B. Shop Drawings:
1. Include plans, elevations, sections, and attachment details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Sustainable Design Submittals:
1. Product data showing compliance with ASHRAE 62.1.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans showing fan rooms and fan system layouts, reflected ceiling plans, and other drawings required to illustrate relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Seismic Qualification Data: Certificates, for fans, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Startup service reports.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans and ventilators, include the following:

1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Seismic Performance: Fans and ventilators are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7 Insert requirement. See Section 230548 "Vibration and Seismic Controls for HVAC."
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Component Importance Factor: 1.0.

2.2 FANS, CENTRIFUGAL - BACKWARD-INCLINED BLADES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Greenheck
 2. Chicago Blower Corporation.
 3. Cincinnati Fan.
 4. Loren Cook Company.
 5. Or equal.
- B. Description:
 1. Factory-fabricated, -assembled, -tested, and -finished, direct-driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 2. Factory-installed and -wired disconnect switch.
- C. Standards: Comply with UL 705.
- D. Housings:

1. Housing Material: Aluminum.
2. Housing Coating: Powder-baked enamel .
3. Housing Assembly: Sideplates continuously welded or attached by continuous Pittsburgh lock seal or similar seal.
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Outlet flange.
7. Discharge Arrangement: Fan scroll housing is field rotatable to any of [seven] [eight] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

E. Wheels:

1. Wheel Configuration: SWSI construction with a precision-spun curved inlet flange and a backplate fastened to shaft with setscrews. Wheels are to be statically and dynamically balanced, and nonoverloading.
2. Wheel and Blade Material: Aluminum.
3. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8, Type A.
4. Wheel and Blade Coating: . Phenolic.
5. Backward-Inclined Airfoil Blades:
 - a. Aerodynamic design.
 - b. Heavy backplate.
 - c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

F. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

G. Bearings:

1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type ball bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.
2. r:
 - a. Extended Lubrication Lines: Extend lines to accessible location.

H. Motor Enclosure: Totally enclosed, fan cooled.

I. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with parallel opposed blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.3 FANS, UTILITY SET

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck
2. Loren Cook Company.
3. Chicago Blower
4. Or equal.

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, direct-driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

C. Standards: Comply with UL 705.

D. Housings:

1. Housing Material: Reinforced steel.
2. Housing Coating: See schedule.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
5. Discharge Arrangement: Fan scroll housing field rotatable to any of [seven] [eight] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

E. Wheels:

1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: Steel.
 - a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8 Type A .
3. Wheel and Blade Coating: See schedule.
4. Backward-Inclined Airfoil Blades:
 - a. Aerodynamic design.
 - b. Heavy backplate.
 - c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

F. Shafts:

1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

G. Bearings:

1. Heavy-duty regreasable ball or roller type in a cast-iron pillowblock housing.
2. Ball-Bearing Rating Life: ABMA 9, L10 of 80,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L10 of 80,000 hours.
4. Extend grease fitting to accessible location outside of unit.

H. Motor Enclosure: Totally enclosed, fan cooled.

I. Accessories:

1. Inlet and Outlet: Flanged.
2. Access Door: Gasketed door in scroll with latch-type handles.
3. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.

2.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

- B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.5 SOURCE QUALITY CONTROL

- A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.
- B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.
- C. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.
- D. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
 - 1. Install roof-mounted fans on roof curbs or support steel. See Drawings for specific requirements.
 - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- E. Unit Support: Install centrifugal fans level on structural curbs. Coordinate with duct connections. Secure units to structural support with anchor bolts.
- F. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation and seismic-control devices.
 - 1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- G. Install units with adequate clearances for service and maintenance.
- H. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 PIPING CONNECTIONS

- A. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest roof receptor with pipe sizes matching the drain connection.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 ADJUSTING

- A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties.
 - 3. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans.

END OF SECTION 233400

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Modulating, single-duct air terminal units.
 2. Critical environment control valve.
 3. Casing liner.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air terminal units.
1. Include plans, elevations, sections, and mounting details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
 4. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.
- B. Seismic Qualification Data: For air terminal units, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Instructions for resetting minimum and maximum air volumes.
 - b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.
- B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Price Industries Limited.
 - 2. ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America.
 - 3. Price Industries Limited.
 - 4. Titus; brand of Johnson Controls International plc, Global Products.
- B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud with +/- 5% accuracy.
- C. Casing: Minimum 20-gauge- thick galvanized steel.
 - 1. Casing Liner: Comply with requirements in "Casing Liner" Article below for "Casing Liner, Subparagraph with "Foil-Faced Liner" .
 - 2. Air Inlet: Round stub connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket. Provide 6" x 6" access door on bottom of VAV boxes.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: AHRI 880 rated, 1 percent of nominal airflow at 3-inch wg Insert value inlet static pressure.
- E. Velocity Sensors: Multipoint array with velocity inlet sensors.
- F. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch 0.08 inch. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.
- G. Direct Digital Controls:
 - 1. Terminal Unit Controller: Pressure-independent, VAV controller and integrated actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes with +/- 5% accuracy.
- H. Control Sequence: See Drawings for control sequences.

2.3 CRITICAL ENVIRONMENT CONTROL VALVE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Accutrol
 2. Phoenix Controls Corporation.
 3. Price Industries Limited.
 4. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
- B. Description: Venturi assembly inside a unit casing with control components inside a protective metal shroud, for general exhaust applications or for exhaust applications where pressurization control via exhaust and supply airflow control is desired and airstream corrosion and contamination may be a concern.
- C. Casing:
1. Material: Type 304 stainless steel or Minimum 22-gauge galvanized steel with phenolic coating .
- D. Airflow Metering: Calibrated shaft position with self-adjusting, spring-loaded cone, and flow feedback.
- E. Direct Digital Controls:
1. Terminal Unit Controller: Controller is to be factory mounted and wired by air terminal manufacturer.
- F. Control Sequence: See Drawings for control sequences.

2.4 CASING LINER

1. Foil-Faced Liner: Minimum 0.001-inch reinforced, nonporous aluminum foil applied to matted insulation airstream face. Encapsulate all insulation edges with sheet metal angles and channels, or tape.
2. Solvent Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

2.5 SOURCE QUALITY CONTROL

- A.
- B. AHRI 880: Test and rate assembled air terminal units in accordance with AHRI 880.
- C. Water Coils: Factory pressure test to 300 psig in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.
- B. Install air terminal units according to NFPA 90A.
- C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance (2'-0" clearance).

3.2 PIPING CONNECTIONS

- A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance (2'-0" clearance).
- B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties," and connect heating coils to supply piping per detail.

3.3 DUCTWORK CONNECTIONS

- A. Comply with requirements in Section 233113 "Metal Ducts for connecting ducts to air terminal units.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

3.5 IDENTIFICATION

- A. Label each air terminal unit with schedule designation, nominal airflow, maximum and minimum factory-set airflows, **and coil type**. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.7 ADJUSTING

- A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Air terminal unit will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Provide 8 hours of training with no more than 4 hours of classroom training in a Bay Area facility or at Las Positas and the balance of training in the field. Provide 20 working days notice to the Owner.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Perforated diffusers.
 - 2. Louver face diffusers.
 - 3. Linear slot diffusers.

- B. Related Requirements:
 - 1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.

- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Perforated Diffuser S1, S2, S3, E`:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 - c. Krueger.

- d. Or equal.
- 2. Devices shall be specifically designed for variable-air-volume flows.
- 3. Material: Steel backpan and pattern controllers, with steel face.
- 4. Finish: Baked enamel, color selected by Architect.
- 5. Face Size: 24 by 24 inches 48 by 24 inches.
- 6. Duct Inlet: Round Square.
- 7. Face Style: Flush.
- 8. Mounting: T-bar.
- 9. Pattern Controller: Adjustable with louvered pattern modules at inlet.
- 10. Dampers: Opposed blade .

B. Louver Face Diffuser S5:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 - c. Krueger
 - d. Or equal.
- 2. Devices shall be specifically designed for variable-air-volume flows.
- 3. Material: Aluminum.
- 4. Finish: Baked enamel, color selected by Architect .
- 5. Face Size: Neck size plus 3" both dimensions
- 6. Mounting: Surface.
- 7. Pattern: Two-way core style.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Slot Diffuser S4:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 - c. Krueger.
 - d. Or equal.
- 2. Devices shall be specifically designed for variable-air-volume flows.
- 3. Material - Shell: Aluminum, [insulated] [noninsulated].
- 4. Material - Pattern Controller and Tees: Aluminum.
- 5. Finish - Tees: Baked enamel, color selected by Architect.
- 6. Slot Width: 1 inch.
- 7. Number of Slots: Two.
- 8. Length: 48 inches.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 233813 - COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes commercial kitchen hoods used in a canopy hood application.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 COORDINATION

- A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

PART 2 - PRODUCTS

2.1 HOOD MATERIALS

- A. Stainless-Steel Sheet: ASTM A 666, Type 304.
1. Minimum Thickness: 0.050 inch.
 2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
 - a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.
 3. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).
- B. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application.
1. Color: As selected by Architect from manufacturer's full range.
 2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.
- C. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.
- D. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

2.2 GENERAL HOOD FABRICATION REQUIREMENTS

- A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.
1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.

2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
 3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
 4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.
 5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.
- B. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.
- C. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.
- D. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.
- E. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.
- F. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.
- G. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.
- H. Refer to detail 66, Q9.1.7FO for hood dimensions.
- I.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods according to manufacturer's written instructions and requirements of authorities having jurisdiction.
- B. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.
- C. Install hoods to operate free from vibration.
- D. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.
- E. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

- F. Set initial temperatures, and calibrate sensors.
- G. Set field-adjustable switches.

END OF SECTION

SECTION 236313 - AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Packaged air-cooled refrigerant condensers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each air-cooled refrigerant condenser.
1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 2. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. Sustainable Design Submittals:
1. Product Data for EA Credit "Enhanced Refrigerant Management": Indicating that products meet requirements for refrigerant management.
 2. Product data showing compliance with ASHRAE 90.1.
- C. Shop Drawings: For air-cooled refrigerant condensers.
1. Include plans, elevations, sections, and mounting details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Seismic Qualification Data: For air-cooled refrigerant condensers, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-cooled refrigerant condensers to include in emergency, operation, and maintenance manuals.

1.5 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

- B. Coordinate location of refrigerant piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Johnson Controls
 - 2. Carrier Corporation; a unit of United Technologies Corp.
 - 3. Trane.
 - 4. Or equal.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. Fabricate and label refrigeration system according to ASHRAE 15 and ASHRAE 34.
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. Seismic Performance: Air-cooled refrigerant condensers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.0.

2.3 PACKAGED AIR-COOLED REFRIGERANT CONDENSERS

- A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
- B. Refrigerant: R454B.
- C. Condenser Coil: Factory tested at 425 psig.
 - 1. Tube: 3/8-inch- diameter seamless copper.
 - 2. Coil Fin: Aluminum.
 - 3. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure Type: Totally enclosed, air-over (TEAO).
 - b. Motor Sizes: Minimum size as indicated. If not indicated, large enough, so driven load will not require motor to operate in service factor range above 1.0.
 - c. Mount unit-mounted disconnect switches on exterior of unit.
 - 4. Coating, Coils: Corrosion resistant.
 - 5. Coating, Casing: Corrosion resistant.
- D. Condenser Fans and Drives:

- E. Casings: Galvanized-steel or zinc-coated-steel treated and finished with manufacturer's standard paint coating Aluminum, designed for outdoor installation with weather protection for components and controls, and with the following:
 - 1. Removable panels for access to controls, condenser fans, motors, and drives.
 - 2. Coating: Corrosion resistant.
 - 3. Lifting holes.

2.4 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.
- E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 750-hour salt-spray test according to ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - 2. Application: Spray.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air-cooled refrigerant condensers.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- C. Maintain manufacturer's recommended clearances for service and maintenance.

- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Refrigerant Piping: Where indicated on Drawings, connect piping to unit with pressure-relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line.
- D. Apply labels to refrigerant lines in accordance with Section 230553, "Identification for HVAC Piping and Equipment."

3.4 ELECTRICAL CONNECTIONS

- A. Install field power to each condenser unit electrical power connection.
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - a. Inspect for physical damage to unit casing.
 - b. Verify that access doors move freely and are weathertight.
 - c. Clean units and inspect for construction debris.
 - d. Verify that all bolts and screws are tight.
 - e. Adjust vibration isolation and flexible connections.
 - f. Verify that controls are connected and operational.
 - 2. Lubricate bearings on fan motors.
 - 3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

4. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
5. Measure and record airflow and air-temperature rise over coils.
6. Verify proper operation of capacity control device.
7. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
8. After startup and performance test, lubricate bearings.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 1. Perform electrical test and visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Verify proper airflow over coils.
- C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- D. Air-cooled refrigerant condensers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers.

END OF SECTION 236313

SECTION 237343.19 - OUTDOOR, CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Outdoor, custom air-handling units.

1.2 ACTION SUBMITTALS

- A. Product Data: For each outdoor, custom air-handling unit.
1. Product information organized to show compliance with each performance requirement of "Performance Requirements" article.
 2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 4. Include unit dimensions and weight.
 5. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 6. Fans:
 - a. Include certified fan-performance curves with system operating conditions indicated. For fans operating at variable speeds include curves in [10] <Insert number> percent speed increments starting at design speed down to minimum speed.
 - b. Include fan-sound power ratings in all eight octave bands. Include inlet or outlet sound power levels to coincide with sound requirements indicated on Drawings.
 - c. Include fan construction and accessories. Submit sufficient information to show product compliance with requirements indicated.
 - d. Include dimensions and weight.
 - e. Include motor ratings, electrical characteristics, and motor accessories.
 7. Vibration isolation product data with performance ratings. Uniquely identify and include information for each different isolator type and indicate for each air-handling unit where each isolator type is being used.
 8. Include certified coil-performance ratings with system operating conditions indicated. Product data to include: dimensions, dry and operating weight, volume of fluid contained, materials of construction, and performance ratings with system operating conditions indicated.
 9. Casing insulation product data and performance ratings.
 10. Access door and access panel product data and performance ratings.
 11. Roofing product data and performance ratings.
 12. Louver product data and performance ratings.
 13. Paint product data and performance ratings.
 14. Electrical product data and performance ratings.
 15. Metal grating product data and performance ratings.
 16. Dampers product data, including housings, linkages, and operators with performance ratings.
 17. Filters product data with performance characteristics.
 18. Hydronic pipe, valves, fittings, vents, strainers, and hydronic accessories product data.
 19. Pipe insulation and jacket product data.
 20. Roof curbs product data.
- B. Sustainable Design Submittals:
1. Product Data: For air filtration performance.
- C. Shop Drawings: For each type and configuration of indoor, custom air-handling unit.
1. Prepared by manufacturer's factory employees with review and sign-off by those individuals responsible for manufacturing the air-handling units.

2. Include plans, elevations, sections, and **[mounting] [attachment]** details.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection.
4. Roofing details.
5. Assembly details of base and casing for units consisting of multiple sections requiring field assembly.
6. Sizes and dimensioned locations of field connections for ductwork, piping, electrical, and controls.
7. Details of casing connections to field-installed ductwork.
8. Size, shape and layout of base members including localized support of internal components.
9. Base materials, thickness, finishes, lifting provisions, and mounting requirements. Uniquely identify and include information for each different base construction. Clearly indicate for each air-handling unit.
10. Recommended points of field attachment with dimensioned locations.
11. Size and location of each access door, including clearing opening size, with door swing indicated.
12. Size and location of each access panel with service equipment superimposed to show relationship of panel to internal equipment.
13. Drain pans and associated piping, with sizes and locations dimensioned, including relationship to internal equipment.
14. Floor drains and associated piping, with sizes and locations dimensioned, including relation to internal equipment.
15. Point-to-point electrical power wiring diagrams including wire size, conduit size, motor controllers sizes, switch types and ratings, receptacle types and ratings, service light fixture types and ratings.
16. Point-to-point control wiring diagrams including cable types and sizes, conduit sizes, and connected control devices.
17. Point-to-point control tubing diagrams including tubing types and sizes, conduit sizes, and connection controls devices.
18. Control panel drawings drawn to scale showing detailed internal layout.
19. Plans, sections and isometric reviews of **[hydraulic] [and] [steam and condensate]** piping systems showing pipe, fittings, flanges, unions, valves, vents, strainers, accessories, specialties and insulation.
20. Indicate code, operating, and maintenance clearances drawn to scale using dashed lines.
21. Indicate weights of internal components, weight of each separately shipped section, and air-handling unit total weight.

D.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, sections, and other details, drawn to scale, showing the items described in this Section and coordinated with all building trades.
- B. Seismic Qualification Data: Certificates for air-handling units, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 4. Restraint of internal components.
- C. Source quality-control reports.
- D. Startup service reports.
- E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Submit O&M manual immediately after the Air Handler's production order has been placed. The O&M manual shall include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams. The O&M manual shall only be provided for the specific model, serial number and location of the specific unit installed for the project. Generic fan data sheet, O&M manual is not acceptable.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Panel Filters: Two set(s) for each air-handling unit. One set for use during construction, if units are used to ventilate the building while still undergoing construction activities. Another set for installation just prior to project turn over to client.

1.6 Quality Assurance

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.8 FACTORY VISITS FOR PRODUCT INSPECTION

- A. While units are being manufactured, and during factory normal working hours, allow escorted access to manufacturing facility for Owner and Owner's designated representatives] to verify product compliance with requirements indicated.
 - 1. As many as (5) persons shall visit the factory for product inspection.
- B. Manufacturer shall provide Owner and Owner's Representative with written notice at least 30 business days before units go into assembly.
- C. Inspection visits shall be scheduled with manufacturer at least 10 business days before visit.
- D. Personnel making visits for purposes of product inspection shall comply with manufacturer requirements for visitors.

- E. Owner will cover the travel costs associated for the Owner and Owner's Representatives.

1.9 DELIVERY, STORAGE, HANDLING

- A. Deliver air-handling units with factory-installed shipping skids and lifting lugs; pack small components in factory-fabricated protective containers. Cover units with heat-shrinkable plastic sheeting suitable for shipping from point of manufacture to Project.
- B. Handle air-handling units carefully to avoid damage to components, casing, and finish. Do not install damaged components; replace and return damaged components to air-handling unit manufacturer.
- C. Store air-handling units in a clean dry place and protect them from weather and construction activities.
- D. Keep air-handling units fully covered and protected during construction. Remove dirt and debris and clean units to a factory-cleaned condition.
- E. Comply with manufacturer's written rigging and installation instructions for unloading air-handling units and moving them to their final locations.
- F. Protect interior of air-handling units from damage and keep inside of units as clean as factory-cleaned condition.

1.10 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of air-handling units that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Casing Structural Performance:
 - 1. Floor: Capable of withstanding positive/negative 8 inches wg of internal static pressure, without exceeding a deflection of L/300 of span.
 - 2. Walls and Roof: Capable of withstanding positive/negative 8 inches wg of internal static pressure, without exceeding a midpoint deflection of L/240 of span.
- F. Casing Leakage Performance, ASHRAE 111: Class 3 leakage or better at plus or minus 8 inches wg.
- G. Casing Thermal Performance:

1. Surface Condensation: Air-handling manufacturer shall evaluate potential for condensation and design and manufacture entire unit casing to prevent condensation at most extreme operating conditions encountered.
 2. Thermal Break: Incorporate a thermal break at each through metal path to prevent condensation from occurring on interior and exterior of casing.
 3. U-Value: Overall U-value or equivalent R-value of casing shall not exceed governing codes and ASHRAE/IES 90.1 while considering the effects of metal-to-metal contact and thermal bridging in calculations.
 4. Condensation shall not form anywhere on unit exterior with a 50 deg F supply air at 95 deg F DB / 87 deg F WB exterior ambient. Manufacturer shall supply an external condensation performance line, plotted on the psychrometric chart, based on actual test data. Plot shall show the exterior conditions at which unit will sweat given the design supply air temperature. Manufacturer shall clearly indicate whether the design conditions will or will not result in external condensation forming anywhere on the unit exterior. If the unit will sweat, indicate where sweating will occur. Unit exterior includes the base, base rail, roof, corners, doors, door frames, and under the cooling coil drain pan.
 5. The AHU Manufacturer shall provide, in writing, a guarantee against condensation forming on the unit exterior under then scheduled supply air temperature and outside air design conditions. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying the units in the field should external condensate form on them. Copies of the guarantee shall be provided to the Engineer and the Owner.
- H. Air Tunnel Aerodynamic Performance: Position air-handling unit internal components and transition between internal components to maintain uniform airflow; minimize sound levels and energy consumption. Use methods indicated and other means to ensure compliance.
1. Use fan inlet and discharge transitions and other devices to maximize system regain and minimize airborne sound levels.
 2. Center system components such as coils, fans, and filters, vertically and horizontally, in the airstream.
 3. Maintain spacing between components such that airflow patterns to adjacent components are as uniform as possible and that component "dead spots" or "jetted areas" are avoided.
 4. Design and install internal structural supports, piping, and conduit that do not block airflow and impede performance of coils, fans, filters, and other unit components, and service space clearances.
- I. Air-Handling Unit Acoustical Performance:
1. Radiated Noise: Noise radiated from air-handling unit casing[**and openings not ducted**] shall not exceed following sound pressure levels when measured [3 feet] **<Insert distance>** away from any exterior surface of unit. Sound pressure levels indicated in each octave band are in decibels (dB) (reference 20 µPa).
 - a. 63 Hz: 76 dB.
 - b. 125 Hz: 76 dB.
 - c. 250 Hz: 74 dB.
 - d. 500 Hz: 60 dB.
 - e. 1000 Hz: 60 dB.
 - f. 2000 Hz: 60 dB.
 - g. 4000 Hz: 60 dB.
- J. Unit Acoustical Performance:
1. Outside Air:
 - a. 125 Hz: 94 dB.
 - b. 250 Hz: 105 dB.
 - c. 500 Hz: 92 dB.
 - d. 1000 Hz: 87 dB.
 - e. 2000 Hz: 86 dB.

- f. 4000 Hz: 83 dB
- 2. Supply Air:
 - a. 125 Hz: 87 dB.
 - b. 250 Hz: 88 dB.
 - c. 500 Hz: 85 dB.
 - d. 1000 Hz: 79 dB.
 - e. 2000 Hz: 74 dB.
 - f. 4000 Hz: 71 dB.
- K. Durability Performance: Design and manufacture air-handling units with underlying requirement to provide a highly durable piece of equipment.
 - 1. Unit Life Expectancy: 25 years.
 - 2. Supporting Documentation: Submit documentation showing proposed products to consider and include design features, components, and materials to satisfy requirement.
- L. Outdoor Environment:
 - 1. Air-handling units specially designed to withstand effects of wind, rain, ice, snow, seismic, air quality, sun, and other influences associated with outdoor installations.
 - 2. Comply with requirements of air-handling unit and governing codes.
- M. Safety:
 - 1. Comply with OSHA regulations.
 - 2. Exposed sharp edges and corners of metal shall be protected or rounded to prevent injury to personnel not wearing gloves.
 - 3. Cover exposed ends of screws with plastic or metal covers to prevent injury to personnel coming in contact with screws.
- N. Serviceability:
 - 1. Hoisting Provisions: Provide full-length hoist rails mounted over the equipment to facilitate service, removal, and replacement of fan motors.
 - 2. Mounting Location: Install internal components in readily accessible locations to facilitate ease of service and replacement.
 - 3. Service Access:
 - a. Internal components shall be serviceable through access sections with doors indicated on Drawings.
 - b. Internal components shall be removable and replaceable through access doors or panels.
 - c. Review requirements for access doors and panels indicated and recommend additional access doors and panels if required for uninhabited service, removal, and replacement of components.
 - 4. Tripping Hazards: Floors in accessible sections of air-handling unit shall be free of standing seams, reinforcing, supports, or section splits located in the walking path that is capable of causing a tripping hazard. Locate section splits immediately adjacent to internal walls.
- O. Quality: Type and thickness of materials indicated are the minimum acceptable. Provide better-quality materials of a heavier thickness if required to comply with performance requirements indicated.
 - 1. If manufacturer's standard construction exceeds requirements indicated, use manufacturer's standard construction.
 - 2. If manufacturer's standard construction does not comply with requirements indicated, modify manufacturer's standard construction to comply with requirements.
- P. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.0.

Q. Vibration Performance: Air-handling unit manufacturer shall evaluate vibration of internal components installed inside of air-handling units and include internal vibration isolation required to limit the vibration transmitted to the building at a low enough level that vibration is not perceived by building occupants.

2.2 CAPACITIES AND CHARACTERISTICS

A. See equipment schedules on Drawings.

2.3 OUTDOOR, CUSTOM AIR-HANDLING UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Haakon Industries.
2. Temtrol; A Nortek Air Solutions Company.
3. HUNTAIR; A Nortek Air Solutions Company.
4. .

2.4 UNIT ARRANGEMENT AND CONFIGURATION

A. Arrangement: Project-specific arrangement and configuration of air-handling units indicated on Drawings. Do not deviate from requirements indicated without submitting a formal request clearly describing each deviation and reason for each deviation, and only after receiving Architect's written acceptance.

B. Mounting Requirements: Indicated on Drawings Units mounted on concrete housekeeping pads Units mounted on structural floor Units mounted on structural-steel frame Units suspended from structure Units mounted on roof curbs.

C. Multiple Sections: Each air-handling unit shall consist of multiple sections for field assembly to comply with requirements indicated on Drawings.

2.5 AIR-HANDLING UNIT BASE

A. Performance:

1. Air-handling unit manufacturer shall design and assemble air-handling unit casing and internal components for attachment and support by air-handling unit structural base.
2. Design air-handling units to be lifted from only the air-handling unit structural base and not the casing.
3. Support air-handling units from only the perimeter base unless otherwise indicated on Drawings.
4. Air-handling unit manufacturer to size and locate intermediate structural base supports as required to comply with structural performance indicated for air-handling unit floors.
5. Level base before factory assembly of air-handling unit casing and internal components to ensure proper fit and alignment.

B. Structural Member Size:

1. Air-handling unit manufacturer shall select size of base members and construction of base to withstand the rigors of loading, unloading, shipping, and rigging without damage to air-handling unit components or misalignment of factory-assembled components.
2. Depth and weight of structural members shall be selected by air-handling unit manufacturer to comply with performance requirements indicated.
3. Depth of perimeter base members is not less than size indicated on Drawings 1/10 of the unit width 8 inches deep Insert requirement.

- C. Structural Member Spacing: Positioned as required to comply with requirements indicated, but not to exceed 24 inches.
- D. Materials: Structural aluminum, ASTM B209, Alloy 6061 T6 structural carbon steel, ASTM A36/A36M structural stainless steel, ASTM A276/A276M, Type304L structural stainless steel, ASTM A276/A276M, Type 316L as indicated on Drawings.
 - 1. Perimeter Members: Angle channel I or W beam shapes tube.
 - 2. Intermediate Members (Spanning Full Width of Unit): Angle channel I or W beam shapes tube.
 - 3. Cross Members (Spanning Intermediate Members): Angle channel tube.
- E. Carbon-Steel Finish, Mill Galvanized: Mill-galvanized carbon steel with weld-damaged areas cleaned, prepared, and painted with galvanized paint after fabrication.
- F. Carbon-Steel Finish: Carbon-steel bases shall be shot-blasted, cleaned, prepared, and after fabrication.
- G. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.
 - 1. Use welding materials with corrosion properties equal to material being welded.
- H. Welding Procedures:
 - 1. Structural Welding Codes: AWS D1.1/D1.1M for carbon steel AWS D1.2/D1.2M for aluminum AWS D1.6/D1.6M for stainless steel.
 - 2. Join structural members to one another using [continuous] [or] [stitch] welds.
 - 3. After welding and fabrication, deburr and grind exposed welds to provide smooth surfaces free of sharp edges.
- I. Penetrations through Base Perimeter: Seal pipe, tubing, and conduit penetrations through base perimeter members to provide a watertight assembly.
- J. Section Joints: Air-handling units consisting of multiple sections for field assembly shall be joined with structural joining plates.
 - 1. Joining plate material type to match base.
 - 2. Joining plate of thickness required to join sections without resulting in a permanent deflection, minimum 1/2 inch thick.
 - 3. Continuously weld joining plates to each mating end of base.
 - 4. Joining plates shall not extend beyond outer edge of adjoining base.
 - 5. Plates to include at least three equally spaced holes for field connection using factory-furnished threaded hardware of a nominal diameter of at least 1/2 inch.
- K. Lifting Provisions: Air-handling unit manufacturer to design and install lifting lugs of size and location required to comply with performance requirements indicated. Lifting lugs extending beyond the base shall be easily removable in the field after unit is installed.
- L. Curb Cap:
 - 1. For air-handling units installed on a continuous perimeter curb, provide air-handling unit base with a continuous structural angle counterflashing.
 - 2. Angle shall extend down vertical face of curb to completely cover wood nailer.
 - 3. Coordinate inside dimension of angle counterflashing with curb dimension and roofing. Provide adequate clearance between angle counterflashing and roofing over curb.

2.6 UNIT CASINGS

- A. Casing Assembly:

1. Appearance:
 - a. Exposed exterior surfaces of casing shall have a neat and finished appearance free of standing seams, exposed reinforcing, and other casing protrusions more than 0.25 inch beyond the exterior skin surface.
 - b. Interior surfaces of casing shall have a neat and finished appearance free of standing seams, exposed reinforcing, and other casing protrusions more than 0.25 inch beyond the skin surface.
2. Dissimilar Metals: Isolate dissimilar metals that are in contact to prevent galvanic action and corrosion.
3. Framing and Supports: Interconnect and support individual casing wall and roof panels using either formed panel construction or framed construction with structural support members. For framed casing construction, materials used to construct casing of structural support members shall be as follows:
 - a. Casings with Aluminum Outer and Inner Skins: Aluminum extrusions in accordance with ASTM B211 Alloy 6063 T6.
 - b. Casings with Galvanized-Steel Outer and Inner Skins: Galvanized steel.
 - c. Casings with Galvanized-Steel Outer Skin and Aluminum or Stainless Steel Inner Skins: Stainless steel.
 - d. Casings with Stainless Steel Outer and Inner Skins: Stainless steel.
4. Seals: Seal interior and exterior joints and seams to make casing air- and watertight. Trim factory-applied sealant flush with adjacent surface.
5. Double-Wall Casings: Consisting of insulation sandwiched between an outer and inner metal wall. Use double-wall casings to construct air-handling units unless septum casings are required.
6. Penetrations: Seal voids around conduit, piping, and tubing penetrations.
 - a. Walls and Roofs:
 - 1) Conduit, Pipe, and Tube Sizes NPS 3 and Smaller:
 - a) Seal void through casing with a nonhardening vapor-barrier caulk covered by an escutcheon on both interior and exterior sides of casing. Back caulk using formed insulation within a sheet metal sleeve.
 - b) Cover penetration and sealing sheet material with metal escutcheon matching adjacent casing material.
 - 2) Larger Conduit, Pipe, and Tube Sizes: Seal annular void using an adjustable compression-type sealing sleeve.
 - b. Floors: Route conduit, pipe, and tube within a floor-mounted pipe sleeve.
 - 1) Sleeve:
 - a) Fabricate sleeve of aluminum, galvanized-steel, or stainless steel pipe to match casing material where penetration occurs.
 - b) Extend top of sleeve above adjacent floor surface to prevent standing water on floor from entering annular space of sleeve.
 - c) Weld sleeve to top of floor for an air- and watertight seal.
 - 2) Seal annular void of sleeve using an adjustable compression seal or **[nonhardening packing material]**.
7. Floor Openings with Metal Grating:
 - a. Factory install walk-on safety gratings over any floor opening large enough to create a safety hazard for operators including, but not be limited to, supply-, return-, and exhaust-air openings.
 - b. Bar Grating:
 - 1) Materials: Use stainless steel grating for aluminum stainless steel grating for stainless steel hot-dip galvanized-steel grating for galvanized-steel painted steel grating for painted steel floors.

- 2) Air-handling unit manufacturer shall select depth and thickness of grating bars to limit deflection to 1/360 of span when subjected to a dynamic load of not less than [500 lb] <Insert weight>.
 - 3) Industry-standard welded grating with bars at least 1-1/2 inches deep by at least 3/16 inch thick with nominal 1-3/16-inch main bar spacing and 4-inch cross bar spacing.
 - 4) Source: Product manufacturer specializing in metal gratings.
 - 5) Grating bearing surface shall extend beyond clear opening in floor at least [2 inches] [3 inches] <Insert dimension>.
- c. Mounting Frame:
- 1) Mount grating in a continuous structural angle or bar frame so no ends of grating bars are exposed. Top of frame to be flush with top of grating.
 - 2) Secure grating to frame with threaded hardware so grating does not move when walked on but can be easily removed from top to gain access behind grating.
 - 3) Continuously weld mounting frame to air-handling unit floor.
 - 4) For applications with automatic dampers installed at floor openings, elevate height of mounting frame and grating to enclose entire damper assembly including jackshaft so walk-on surface of grating is above damper assembly.
8. Waterproof Floors: Continuously weld floor joints, seams, and penetrations to completely seal floor. Roll all edges of floor up at least [1 inch] <Insert dimension> to create a shallow tub capable of holding standing water.
9. Duct Connections - Direct to Casing: Frame and reinforce unit casing around perimeter of unit duct openings to accommodate direct attachment of field-installed ductwork. Coordinate requirements with Installer to accommodate field connection.
10. <Insert requirements>.
- B. Materials for Outer Skin of Casing Walls and Roofs:
1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 Insert coating coating; minimum (nominal) 18 gauge 16 gauge 14 gauge Insert value thick.
 2. Aluminum Solid Sheet: ASTM B209; Alloy 3003-H14, smooth stucco-embossed texture leather-grain texture Insert finish finish; minimum (nominal) 0.063 inch 0.080 inch Insert value thick.
 3. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304 Type 304L Type 316 Type 316L Insert type; No. 2D 4 Insert finish finish; minimum (nominal) 18 gauge 16 gauge 14 gauge Insert value thick.
 4. Application: See Drawings for application of different materials indicated.
- C. Materials for Inner Skin of Casing Walls and Roofs:
1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; [G90] <Insert coating> coating, minimum (nominal) 20 gauge 18 gauge thick.
 2. Galvanized-Steel Perforated Sheet: ASTM A653/A653M; G90 Insert coating coating, minimum (nominal) 20 gauge 18 gauge 16 gauge Insert value thick.
 3. Aluminum Solid Sheet: ASTM B209; Alloy 3003-H14, smooth Insert finish finish; minimum (nominal) 0.032 inch 0.040 inch 0.063 inch 0.080 inch Insert value thick.
 4. Aluminum Perforated Sheet: ASTM B209; Alloy 3003-H14, smooth Insert finish finish; minimum (nominal) 0.032 inch 0.040 inch 0.063 inch 0.080 inch Insert value thick.
 5. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M; Type 304 Type 304L Type 316 Type 316L Insert type; No. 2D Insert finish finish; minimum (nominal) 20 gauge 18 gauge 16 gauge Insert value thick.
 6. Stainless Steel Perforated Sheet: ASTM A240/A240M or ASTM A480/A480M; Type 304 Type 304L Type 316 Type 316L Insert type; No. 2D Insert finish finish; minimum (nominal) 20 gauge 18 gauge 16 gauge Insert value thick
 7. Application: See Drawings for application of different materials indicated.
- D. Materials for Floor Walking Surface:

1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 Insert coating coating; minimum (nominal) 14 gauge 12 gauge 10 gauge Insert value thick.
 2. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304 Type 304L Type 316 Type 316L Insert type; No. 2D Insert finish finish; minimum (nominal) 14 gauge 12 gauge 10 gauge Insert value thick.
 3. Carbon-Steel Diamond Treadplate: ASTM A786/A786M, painted finish; minimum (nominal) 0.125 inch 0.1875 inch Insert value thick.
 4. Aluminum Diamond Treadplate: ASTM B632/B632M, Alloy 6061 T6; mill finish; minimum (nominal) 0.125 inch 0.1875 inch Insert value thick.
 5. Stainless Steel Diamond Treadplate: ASTM A793; Type 304 Type 304L Type 316 Type 316L Insert type; mill finish; minimum (nominal) 0.125 inch 0.1875 inch Insert value thick.
 6. Application: See Drawings for application of different materials indicated.
- E. Materials for Underside of Floor Insulation:
1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 Insert coating coating, minimum (nominal) 18 gauge 16 gauge Insert value thick.
 2. Aluminum Solid Sheet: ASTM B209; Alloy 3003-H14, smooth Insert finish finish; minimum (nominal) 0.040 inch 0.063 inch 0.080 inch Insert value thick.
 3. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M; Type 304 Type 304L Type 316 Type 316L Insert type; No. 2D 4 Insert finish finish; minimum (nominal) 18 gauge 16 gauge Insert value thick.
 4. Application: See Drawings for application of different materials indicated.
- F. Materials for Internal Walls:
1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 Insert coating coating; minimum (nominal) 16 gauge 14 gauge Insert value thick.
 2. Aluminum Solid Sheet: ASTM B209; Alloy 3003-H14, smooth finish; minimum (nominal) 0.063 inch 0.080 inch Insert value thick.
 3. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304 Type 304L Type 316 Type 316L Insert type; No. 2D finish; minimum (nominal) 16 gauge 14 gauge Insert value thick.
 4. Application: See Drawings for application of different materials indicated.
- G. Surfaces in Contact with Airstream:
1. Comply with ASHRAE 62.1 and NFPA 90A.
 2. Glass or mineral-fiber insulation installed behind perforated metal shall be encapsulated to prevent insulation fibers from entering the airstream by using a polymer sheet material tightly woven glass cloth material that does not impact the acoustical absorption properties of insulation.
- H. Insulation for Casing Walls and Roofs Not Exposed to Airstream:
1. Materials Not Exposed to Airstream: Glass or mineral-fiber board injected or sprayed polyurethane foam polyurethane foam board insulation with a minimum nominal density of 2 lb/cu. ft. 3 lb/cu. ft. Insert density.
 2. R-Value: Minimum R-8 R-10 R-12 R-16 Insert value.
 3. Thickness: Minimum 2 inches 2.5 inches 3 inches 4 inches Insert dimension.
 4. Insulation shall completely fill the casing cavity so no voids exist.
- I. Insulation for Casing Walls and Roofs Exposed to Airstream:
1. Materials Exposed to Airstream: Glass or mineral-fiber board insulation with a minimum density of 2 lb/cu. ft. 3 lb/cu. ft. 6 lb/cu. ft. Insert density.
 2. R-Value: Minimum R-8 R-10 R-12 R-16 Insert value.
 3. Thickness: Minimum 2 inches 2.5 inches 3 inches 4 inches Insert dimension.
 4. Insulation shall completely fill the casing cavity so no voids exist.
- J. Insulation for Casing Floors:

1. Materials: Glass or mineral-fiber board insulation injected or sprayed polyurethane foam polyurethane foam board insulation with a minimum nominal density of 2 lb/cu. ft. 3 lb/cu. ft. Insert density.
2. R-Value: Minimum R-8 R-10 R-12 R-16 Insert value.
3. Thickness: Minimum 2 inches 2.5 inches 3 inches 4 inches Insert dimension.
4. Insulation shall completely fill the casing cavity so no voids exist.

K. Access Doors:

1. Application: Install access doors in air-handling units at locations indicated on Drawings Install access doors downstream and upstream of all internal components Insert requirement.
2. Adjustment: Design doors for field adjustment capable of maintaining specified leakage rate.
3. Mounting Height: Install bottom of door frame within 2 inches Insert dimension of air-handling unit floor walking surface. Where internal conditions require access doors to be mounted higher above air-handling unit floor, include permanent retractable stairs inside and outside of air-handling unit to limit stair risers to 6 inches.
4. Performance: Leakage as required to satisfy overall unit leakage performance indicated, but not more than [1.0 cfm] <Insert leakage rate> per door when tested at 10 inches wg.
5. Fabrication: Formed and reinforced, constructed of same materials and thicknesses as casing.[
Where doors are installed in casing walls with perforated interior, install doors with solid interior.]
6. Swing: Arrange doors to be opened against pressure, unless otherwise indicated on Drawings.
7. Frame: Extruded aluminum with thermal break galvanized steel stainless steel with welded mitered corners.
8. Handles:
 - a. Secure door closed using not less than two [roller-style]latches with handles located at quarter points along door height.
 - b. If three latches with handles are included, install one at midpoint of door height and equally space others.
 - c. Air-handling unit manufacturer has option to use a multipoint latching mechanism that is operable from a single door handle located at midpoint of door height, but secures door to frame at top, bottom, and handle location.
 - d. Include door handles on outside and inside of door to allow operator access to open and close door from outside and inside of unit.
 - e. Field adjustable to accommodate changes to fit and gasket compression.
 - f. Durable product capable of withstanding repeated opening and closing of door while operating under design pressure without damage.
9. Hinges: Minimum of two hinges minimum of three hinges full-length, concealed, stainless steel piano hinge.
10. Gasket:
 - a. Design: Specially formed with an internal air chamber specifically designed to seal on two surfaces without taking a permanent set.
 - b. Dual Gaskets: Primary and secondary gasket.
 - c. Location: Install gaskets around entire perimeter of doors or frames.
 - d. Material: Neoprene.
 - e. Protection: Seat gasket in a protective metal ribbed chamber integral to door or door frame to protect gasket from damage by operator incidental contact.
 - f. Service: Field replaceable.
 - g. Adhesive-backed tape-type gaskets adhered to a single flat surface are unacceptable.
11. Size of Door Frame Clear Opening: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.
 - a. Width: At least 18 inches 24 inches Insert dimension clear inside of door frame.
 - b. Height: Full clear height of unit casing up to a maximum height of 60 inches 72 inches Insert dimension clear inside of door frame.
 - c. Door sizes indicated on Drawings.

12. Safety Latches and Stops:
 - a. Safety Latches: Install safety latch with retainers on outward swing doors that do not open against pressure to allow restricted travel for purpose of pressure relief and so that doors do not open uncontrollably due to inside pressure.
 - b. Stops: Install cushioned door stops on inward swinging doors where necessary to limit door travel that could potentially damage the door or internal components.
13. Tie-Backs: Install tie-backs with retainers on[**outward-swinging**] access doors to hold doors in an open position during service.
14. Locks: Include each access door with an integral key lock. Pad locks are unacceptable.
 - a. Incorporate key lock into door handle where feature is available.
 - b. A common key shall be used to lock and unlock access doors of [**each**] [**all**] air-handling unit(s).
 - c. Include two Insert value keys for each air-handling unit.
 - d. Lock access doors at factory to ensure that unauthorized access is in place before air-handling unit packaging and shipment.
15. Windows:
 - a. Construction: Fabricate windows with frame mounted in access doors of double-glazed safety glass with an airspace between panes and interior and exterior seals.
 - b. Condensation Control: Install desiccant material in airspace between panes if necessary to prevent condensation from forming on glazing.
 - c. Clear Viewing Size: Minimum 6 inches 8 inches 12 inches Insert dimension, square[**or round**].
 - d. Mounting Location: Center window in door width. For doors up to 60 inches Insert dimension high, locate top of window 6 inches Insert dimension below top of door. For taller doors, locate center of windows at optimal viewing height, approximately 60 inches Insert dimension above floor adjacent to unit.
 - e. Application: Install windows in all access doors only access doors servicing fans only access doors servicing fans and filters only access doors servicing coils, dampers, heat wheels, fans, filters, and UV-C lamps Insert requirement.
16. Nameplates:
 - a. On each access door, include a nameplate defining the access to service within. Nameplates shall be included for, but not be limited to, the following:
 - 1) Dampers.
 - 2) Filters.
 - 3) Cooling Coils.
 - 4) Heating Coils.
 - 5) Heat Recovery Coils.
 - 6) Supply Fans.
 - 7) Air-handling unit designation.
 - 8) Where door access is to multiple components, list all components accessed. For example: Filter/Cooling Coil.
 - 9) For each door that does not open against static pressure, include a warning sign stating: "DANGER: DOOR UNDER PRESSURE. DO NOT OPEN WITH FAN ON."
 - b. Lettering Size and Style: At least [1-inch-] high, block style.
 - c. Material: Lettering engraved in black plastic on a white plastic back. Engraving shall penetrate through black plastic so lettering reads white.
 - d. Attachment: Attach nameplates to door using high-strength bonding cement and [**stainless steel**] screws.
 - e. Mounting Location:
 - 1) For access doors without windows, locate top of nameplate [6 inches] <Insert **dimension**> from top of door and center in door width.
 - 2) For access doors with windows, locate nameplate directly above below window frame and center in door width.

- 3) Align nameplates of all doors for uniform placement.
- L. Access Door Gutters and Downspouts: Install rain gutters directly above each access door to deflect rain away from doors.
1. Construct gutters of same materials and finish as casing exterior.
 2. Extend gutters beyond vertical edge of doors at least [3 inches] <Insert dimension>.
 3. Install gutter with a downspout located adjacent to access door frame. Construct downspout of aluminum stainless steel pipe copper tube of a size determined by unit manufacturer. Terminate downspout at a height below unit floor.
- M. Access Panels:
1. Performance: Leakage as required to satisfy overall unit leakage performance indicated.
 2. Fabrication: Formed and reinforced panels of same material and thickness as casing.
 3. Fasteners: Adjustable, reusable type for multiple operations without degradation due to reuse. [**Do not use screws capable of stripping.**]
 4. Arrangement: Panels removable from exterior side of casing.
 5. Gasket: EPDM, neoprene, or santoprene similar to access doors, applied around entire perimeter of panels or frames.
 6. Location and Size:
 - a. Coils: Oversized access panel to allow removal and replacement without impacting adjacent casing.
 - b. Electric Heaters: Oversized access panel to allow removal and replacement without impacting adjacent casing.
 - c. Fans: Oversized access panel to allow removal and replacement of entire fan assembly [including base]without impacting adjacent casing.
 - d. Heat Wheels and Heat Exchangers: Oversized access panel to allow removal and replacement of internal components without impacting adjacent casing.
 - e. Humidifiers: Oversized access panel to allow removal and replacement without impacting adjacent casing.
 - f. <Insert component>.
 7. Nameplates:
 - a. On each access panel, include a nameplate defining the access to service within. Nameplates shall be included for, but not be limited to, the following:
 - 1) Cooling Coils.
 - 2) Heating Coils.
 - 3) Electric Heaters.
 - 4) Heat Wheels.
 - 5) Fixed Plate Exchangers.
 - 6) Heat Pipe Heat Exchangers.
 - 7) Humidifiers.
 - 8) Supply Fans.
 - 9) Exhaust Fans.
 - 10) Return Fans.
 - 11) <Insert description>.
- N. Standing-Seam Metal Roof: Construct air-handling unit roof casing with standing seams designed for waterproof roofing applications.
1. Construct air-handling unit roof using same materials and finish as walls.
 2. Slope roof away from primary access side of unit at not less than 1 2 Insert number percent.
 3. For air-handling units shipped in multiple sections, include standing-seam joiners at each split with adhesive, hardware, and cover strips for field joining by Installer.
- O. Roofing Membrane:

1. Cover entire roof with a roofing membrane. Extend membrane down sides of unit a sufficient distance to provide a waterproof roof assembly and secure in place with a metal flashing matching casing material and finish.
 - a. Roofing membrane shall have an elongation of at least 450 percent when tested in accordance with ASTM D412.
 - b. Roofing membrane shall not become brittle at temperatures down to minus 40 deg F.
2. Slope unit roof away from primary access side of unit at a slope in accordance with roofing manufacturer's written instructions, but not less than 1 2 Insert number percent.
3. Application: Factory or field applied as determined by air-handling unit manufacturer; in accordance with roof manufacturer's written instructions.
 - a. Field-applied roofing to be supervised by an air-handling unit manufacturer's factory service representative.

P. Liquid-Applied Roofing:

1. Cover entire roof with a liquid-applied roofing. Extend liquid-applied roofing down sides of unit a sufficient distance to provide a waterproof roof assembly and cover sides with a metal flashing matching casing material and finish.
 - a. Cured roofing shall have an elongation of at least 500 percent at 77 deg F and at least 300 percent at 0 deg F, when tested in accordance with ASTM D412.
 - b. Roofing shall not become brittle at temperatures down to minus 40 deg F.
2. Slope unit roof away from primary access side of unit at a slope in accordance with roofing manufacturer's written instructions, but not less than 1 2 Insert number percent.
3. Application: Factory or field applied as determined by air-handling unit manufacturer; in accordance with roof manufacturer's written instructions.
 - a. Field-applied roofing to be supervised by an air-handling unit manufacturer's factory service representative.

Q. Service Corridors:

1. Description: Integral walk-in service corridors with heated cooled ventilated temperature-controlled indoor environment for weather-protected service access to unit access doors and factory-installed piping electrical controls.
2. Size and Arrangement: As indicated on Drawings Full length of unit by 6 feet deep Insert requirements.
3. Construction: Base, floor, walls, and roof to match air-handling unit.
4. Access Doors:
 - a. Width: Minimum 36-inch 42-inch Insert dimension clear inside frame opening.
 - b. For double-door applications, include door frames with removable center mullions for unrestricted access.
5. Electrical: Factory install and wire service lights with switches receptacles.
6. Indoor Environmental Control: Factory install self-contained, packaged HVAC equipment required to thermostatically controlled indoor environment to maintain following indoor conditions:
 - a. Minimum Temperature: <Insert temperature>.
 - b. Maximum Temperature: <Insert temperature>.
 - c. Maximum Coincident Relative Humidity: [60] <Insert number> percent.
7. Field Connections to Factory-Installed Piping, Electrical, and Controls: Arranged to make field connections to factory terminations inside of service corridor and within <Insert distance> of floor walking surface. Frame openings in air-handling unit floor to accommodate field connections.

R. Piping Enclosures:

1. Description: Integral accessible enclosure(s) to house field-installed piping from below and connecting to hydronic and steam coils and steam humidifiers.

2. Size: Adequate clearance for field installation of piping, valves, accessories, and associated insulation.
 - a. Maintain at least [6 inches] **<Insert dimension>** of clearance between inside of enclosure and face of pipe insulation at most restricted point.
3. Construction:
 - a. Base, Walls, and Roof: Match air-handling unit.
 - b. Floor: Not required, open to below.
 - c. Access Doors:
 - 1) Size for full front access to piping, valves, and accessories installed within enclosure.
 - 2) Double-door applications with removable center mullions for unrestricted access.
4. Electrical: Factory install and wire service light with switch receptacle for each enclosure.

2.7 WALL LOUVERS

A. Wall Louvers, Drainable Blade:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Greenheck Fan Corporation.
 - b. Pottorff.
 - c. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 - d. Insert manufacturer's name.
2. Source Limitations: Obtain louvers from single source from single manufacturer.
3. Performance:
 - a. Air Pressure Drop, Design: Less than [0.1 inch wg] **<Insert pressure drop>** at airflow indicated on Drawings.
 - b. Air Pressure Drop, Rating: Less than 0.1 inch wg at free area intake face velocity of 700 fpm.
 - c. Face Velocity: If louver size is not indicated on Drawings, size louver for [500-fpm] **<Insert value>** velocity across louver free area.
 - d. Free Area: 54 percent or more for a 48-by-48-inch representative sample.
 - e. AMCA 500-L: Beginning point of water penetration at 870 fpm.
4. Features:
 - a. Depth: 4 inches.
 - b. Frame: 0.080 inch thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy.
 - c. Blades: 0.080 inch thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy; stationary in horizontal position, drainable.
 - d. Stationary vertically positioned blades.
 - e. Bird Screen: 0.5-by-0.040-inch expanded flattened aluminum attached to back of louver.
 - f. Finish: Match exterior casing.
5. Air-Handling Unit Factory Assembly:
 - a. Install louver face flush with exterior of casing and seal to provide a weathertight installation.
 - b. Secure louver in casing and include additional bracing if required to handle loading of extreme outdoor environmental performance indicated.
6. Application: Factory install louvers in air-handling casing at locations indicated on Drawings for each outdoor intake for each outdoor intake and exhaust discharge.

B. Wall Louvers, Wind-Driven Rain:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Greenheck Fan Corporation.
 - b. Pottorff.
 - c. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 - d. Insert manufacturer's name.
 2. Source Limitations: Obtain louvers from single source from single manufacturer.
 3. Performance:
 - a. Air Pressure Drop, Design: Less than [0.1 inch wg] **<Insert pressure drop>** at airflow indicated on Drawings.
 - b. Air Pressure Drop, Rating: Less than 0.1 inch wg at free area intake face velocity of 800 fpm.
 - c. Face Velocity: If louver size is not indicated on Drawings, size louver for [500-fpm] **<Insert value>** velocity across louver free area.
 - d. Free Area: 47 percent or more for a 48-by-48-inch representative sample.
 - e. AMCA 500-L:
 - 1) Wind-Driven Rain Penetration Class: Class A, with wind-driven rain penetration effectiveness of 99 percent at core velocity up to [408 fpm] **<Insert velocity>** with 50-mph wind and rainfall of 8 inches per hour.
 - 2) Intake Discharge Loss Class: Class 2.
 4. Features:
 - a. Depth: 5 inches.
 - b. Frame: 0.080 inch thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy.
 - c. Blades: 0.063 inch thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy; stationary in horizontal position, double drainable, and sightproof.
 - d. Stationary vertically positioned blades.
 - e. Bird Screen: 0.5-by-0.040-inch expanded flattened aluminum attached to back of louver.
 - f. Finish: Match exterior casing.
 5. Air-Handling Unit Factory Assembly:
 - a. Install louver face flush with exterior of casing and seal to provide a weathertight installation.
 - b. Secure louver in casing and include additional bracing if required to handle loading of extreme outdoor environmental performance indicated.
 6. Application: Factory install louvers in air-handling casing at locations indicated on Drawings for each outdoor intake for each outdoor intake and exhaust discharge.
- C. Wall Louvers, Hurricane Rated:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Greenheck Fan Corporation.
 - b. Pottorff.
 - c. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 - d. Insert manufacturer's name.
 2. Source Limitations: Obtain louvers from single source from single manufacturer.
 3. Certification: Miami-Dade Notice of Acceptance.
 4. Performance:
 - a. Air Pressure Drop, Design: Less than [0.1 inch wg] **<Insert pressure drop>** at airflow indicated on Drawings.
 - b. Air Pressure Drop, Rating: Less than 0.1 inch wg at free area face velocity of 1500 fpm.

- c. Face Velocity: If louver size is not indicated on Drawings, size louver for [500-fpm] <Insert value> velocity across louver free area.
 - d. Free Area: 33 percent for a 48-by-48-inch representative sample.
 - e. AMCA 500-L, Wind-Driven Rain Penetration Class: Class A, with wind-driven rain penetration effectiveness of 100 percent at core velocity up to [960 fpm] <Insert velocity> with 50-mph wind and rainfall of 8 inches per hour.
 - f. AMCA 540 and AMCA 550: Listed.
 - g. Wind Loading: Positive 160 psf, negative 140 psf.
5. Features:
- a. Depth: 6 inches nominal.
 - b. Frame: 0.095 inch thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy.
 - c. Blades: 0.080 inch thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy; stationary in vertical position.
 - d. Bird Screen: 0.5-by-0.063-inch expanded flattened aluminum attached to back of louver in a removable frame.
 - e. Finish: Match exterior casing.
6. Air-Handling Unit Factory Assembly:
- a. Install louver face flush with exterior of casing and seal to provide a weathertight installation.
 - b. Secure louver in casing and include additional bracing if required to handle loading of extreme outdoor environmental performance indicated.
7. Application: Factory install louvers in air-handling casing at locations indicated on Drawings for each outdoor intake for each outdoor intake and exhaust discharge.

2.8 INTERNAL STRUCTURAL SUPPORTS

- A. General:
1. Air-handling unit manufacturer shall design and assemble air-handling unit internal structural supports for attachment and support by air-handling unit structural base.
 2. Factory install structural supports for internal support casing if required to comply with casing structural performance.
 3. Factory install hoist beams and rails over equipment to comply with performance requirements for service.
- B. Structural Member Size and Spacing:
1. Size: Air-handling unit manufacturer shall select size of members and construction to do the following:
 - a. Withstand the rigors of loading, unloading, shipping and rigging without damage to air-handling unit components or misalignment of factory-assembled casing and components.
 - b. Comply with performance requirements indicated.
 2. Spacing: Positioned as required to comply with requirements.
- C. Materials: Structural aluminum, ASTM B209, Alloy 6061 T6 structural carbon steel, ASTM A36/A36M structural stainless steel, ASTM A276/A276M, Type 304L structural stainless steel, ASTM A276/A276M, Type 316L as indicated on Drawings.
1. Structural Supports: Angle channel I or W beam shapes tube shapes selected by air-handling unit manufacturer for application.
 2. Hoist Beams for Internal Components (Spanning Full Width of Unit): I or W beam shapes.
- D. Carbon-Steel Finish, Mill Galvanized: Mill-galvanized carbon steel with weld damaged areas cleaned, prepared, and painted with galvanized paint after fabrication.

- E. Carbon-Steel Finish: Carbon-steel bases shall be shot-blasted, cleaned, prepared, and after fabrication.

2.9 FACTORY-MANUFACTURED ROOF CURBS

A. General:

1. Air-handling unit manufacturer shall furnish a continuous perimeter curb for **[each] [each roof-mounted] <Insert requirement>** air-handling unit.
2. Design curb to support operating air-handling unit from its base with attachments to withstand environmental forces. Curbs with intermediate reinforcing as required.
3. Frame curb for ductwork, piping, and conduit located within curb.
4. Fabricate curb to maintain top of curb level even where installed on sloping substrate.
5. Furnish top of curb to provide for field attachment of unit base to curb.
6. Furnish curb with a fully mitered and raised cant where required by adjacent insulation and roofing.
7. Include bottom of curb with attachment flange that extends beyond base of curb and is suitable for attachment to substrate.
8. Furnish curb with integral crickets if required by roof installation.

B. Size:

1. Size curb to provide continuous support of unit base and to fit within footprint of unit perimeter base.
2. Height:
 - a. See Drawings.

C. Materials:

1. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 Insert coating coating; minimum (nominal) 14 gauge 12 gauge 10 gauge Insert value thick. Treat welded areas to protect against corrosion with a zinc-rich coating.
2. Stainless Steel Solid Sheet: ASTM A240/A240M or ASTM A480/A480M, Type 304 Type 304L Type 316 Type 316L Insert grade grade; No. 2D Insert finish finish; minimum (nominal) 14 gauge 12 gauge 10 gauge Insert value thick.

D. Insulation:

1. Insulate curb to provide thermal performance equal to unit casing.
2. Completely encapsulate insulation within metal curb.

E. Gaskets:

1. Include a continuous gasket between air-handling unit base and top of curb for an air and watertight seal.
2. Select gasket materials suitable for installation while complying with requirements indicated.
3. Furnish gasket materials with air-handling units and curbs for field installation.
4. Air-handling unit manufacturer to provide instruction to installer on proper installation techniques.

2.10 CENTRIFUGAL FAN ARRAYS

A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

1. Greenheck Fan Corporation.
2. Lau Fan.
3. Loren Cook Company.
4. Rosenberg USA, Inc.
5. Twin City Fan & Blower.
6. ZIEHL-ABEGG Inc.

7. ebm-papst Inc.
 8. Insert manufacturer's name.
- B. Sourcing Option: In lieu of sourcing fan array assemblies from a specialty fan manufacturer, air-handling unit manufacturer has option to furnish in-house fan array assemblies that achieve equal or better performance while complying with other requirements indicated.
- C. Operating Performance:
1. Air-handling unit manufacturer shall account for, and include in, submitted fan selections any static pressure drops associated with unit, and system effect due to fan operating in the air-handling unit.
 - a. Add additional static pressure to fan scheduled total static pressure.
 - b. If fan motor horsepower is increased, notify Architect.
 2. Fans shall have sharply rising pressure characteristics at operating point and stable in operation. Fan horsepower characteristics shall be self-limiting and non-loading.
 3. Fan speed, brake horsepower, and sound power levels indicated are maximum acceptable.
 4. Scheduled motor horsepower, airflow rate, and static pressure are minimum acceptable. Motor horsepower shall be capable of handling maximum horsepower of fan at scheduled speed.
 5. At a minimum, fans shall have AMCA class indicated on Drawings.
 - a. Fan operating limits shall be in accordance with AMCA 99 for AMCA class indicated.
 - b. If AMCA class is not indicated, use AMCA 99 as basis for determining AMCA class.
 - c. AMCA class selected shall be capable of accommodating a plus 10 percent increase to fan static pressure indicated on Drawings.
 6. Motor starting torque shall exceed fan speed-torque requirements.
 7. Airflow Profile:
 - a. Fan arrangement within fan array shall produce a uniform airflow and velocity profile across air-handling unit air tunnel when measured 12 inches Insert dimension upstream of fan inlet and 48 inches Insert dimension downstream of fan inlet.
- D. Vibration Balance:
1. Each fan/motor assembly shall be factory balanced to AMCA 204, BV-5, Balance Quality Grade G1.0 BV-4, Balance Quality Grade G2.5 BV-3, Balance Quality Grade G6.3 Balance Quality Grade indicated on Drawings Insert fan vibration balance requirements or better through entire operating speed range from minimum speed to maximum speed. If minimum speed is not indicated on Drawings, assume minimum speed to be 10 20 Insert number percent of design speed.
 2. Identify and record each speed and speed range within the fan operating range that could cause potential vibration problems.
 3. Submit test reports as an informational submittal for Project record.
- E. Vibration Isolation: Install vibration isolation on each fan/motor assembly in the fan array, except vibration isolation may be omitted on fans/motor assemblies balanced to AMCA 204, BV-5, with a maximum residual imbalance of 0.22-in./s peak, filter in.
- F. Operation and Service Requirements:
1. Remaining fans in array shall continue to operate with one or multiple failed fans.
 2. Each fan/motor assembly of fan array shall be capable of lock-out/tag-out procedure without interrupting operation of other fans in the array.
 3. Each fan/motor assembly shall be controlled through a variable-frequency controller, except for fans with electronically commutated (EC) motors having integral motor controls.
 - a. Include a dedicated variable-frequency controller for each fan/motor assembly in the fan array.
 - b. If fan array is served from a single variable-frequency controller, include a redundant variable-frequency controller with automatic switchover in event of primary variable-frequency controller failure.

4. A single mechanical, electrical, and control device failure shall not result in a fan array available capacity of less than [33] <Insert number> percent of air-handling unit total scheduled airflow capacity.
 5. Fan wheel/motor assembly shall pass through the air-handling unit access door servicing fans. Entire individual fan assembly shall pass through the door to the room where air-handling unit is located.
 6. Design and incorporate features to permit safe, rapid, and economical maintenance.
- G. Airflow Measurement, Local Indication, and Remote Monitoring:
1. Each fan within fan array shall include airflow measurement indication in cfm.
 2. Include airflow totalization of all operating fans in fan array.
 3. Airflow measurement instrumentation shall not restrict or deflect air travel through fan and shall not impact fan air and sound performance.
 4. Include digital display of individual fan airflow and total fan array airflow on face of fan control panel.
 5. Include a 4- to 20-mA output signal for remote monitoring of total fan array airflow.
- H. Fan Array Local Control:
1. Include fan control panel with operator interface to control fan array locally through the fan control panel and to switch to control of fan array through a remote-control source.
 2. Local control shall include on/off operation [**and speed adjustment**] for entire fan array and each individual fan/motor in fan array.
- I. Fan Array Remote Control:
1. Include fan control panel with control interface for remote control.
 2. Fan array on/off operation shall be remotely controlled through a single hardwired digital output signal.
 3. Fan array speed shall be remotely controlled through a single hardwired analog (4- to 20-mA) output signal.
- J. Fan Base, Stackable Fan Units:
1. Mount fan/motor on aluminum galvanized-steel powder-coated steel base.
 2. Include base and vibration isolators in accordance with requirements indicated.
 3. Weld structural members to form a rigid base.
 4. Size and design the base construction to withstand the rigors of shipping and rigging.
 5. Include the base with lifting lugs or holes.
- K. Fan Frame:
1. Construct frame of aluminum galvanized steel powder-coated steel.
 2. Reinforce and brace frame to prevent excessive deflection and pulsation.
 3. Include stiffeners to form a rigid frame that is free of structural resonance and vibration.
- L. Fan Panel:
1. Construct fan panel of continuously welded aluminum galvanized steel powder-coated steel.
 2. Reinforce and brace fan panel to prevent excessive deflection and pulsation.
 3. Include stiffeners to form a rigid panel that is free of structural resonance and vibration.
- M. Fan Inlet Cone:
1. Include a precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of fan blades.
 2. Inlet cone shall be a smooth hyperbolic shape.
 3. Inlet cone shall be a single piece, constructed of aluminum or powder-coated steel.
 4. Fasten inlet cone to fan panel using bolts, nuts, and washers to provide a positive and secure attachment that can be field removable.

N. Fan Wheel:

1. Fan blades shall be a true hollow airfoil shape, welded to backplate and wheel cone.
2. Construct blades of aluminum, reinforced for AMCA fan class.
3. Design blades to provide smooth airflow over all surfaces of blade.
4. Construct fan hubs of aluminum with integral bracing for extra strength and stiffness.
 - a. Castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects.
 - b. Clean surfaces of castings by blasting, pickling, or any other standard method.
 - c. Mold-parting fins and remains of gates and risers shall be chipped, filed, and ground flush.
 - d. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance.
5. Hubs shall be keyed and setscrewed to motor shaft for positive attachment.
6. Construct wheel backplates of aluminum.
7. Select entire rotating assembly so first critical speed is at least 30 Insert number percent greater than fan design speed and at least 20 Insert number percent greater than maximum speed in AMCA fan class.

O. Fan Drive:

1. Direct drive, arrangement 4 in accordance with AMCA 99.
2. Adjust wheel width and diameter to match motor speed while providing performance scheduled.
3. Fasten fan wheel directly to motor shaft using a key in motor shaft and setscrew.
4. Construct motor base and pedestal supports of aluminum galvanized steel powder-coated steel.
5. Fan Speed Limitation:
 - a. Fan speed at design conditions indicated shall not exceed speed on motor nameplate.
 - b. Do not select fans to operate at motor speeds greater than motor nameplate.

P. Fan Motors: See "Fan Motors" Article for ac motors.

Q. Fan Enclosure:

1. Include each fan in fan array with integral single-wall enclosure constructed of solid aluminum galvanized-steel powder-coated steel sheet.
2. Enclosure shall not increase fan array length beyond size indicated on Drawings.
3. Enclosure shall not add static pressure loss.
4. Enclosure shall provide a physical separation between operating adjacent fans to prevent negative performance.

R. Fan Sound Silencing Enclosure:

1. Include each fan of fan array with integral sound silencer enclosure to reduce the bare fan discharge sound levels by at least 8 15 Insert value dB through octave band frequencies from 125 to 8000 Hz.
2. Enclosure shall not increase the fan array length beyond size indicated on Drawings.
3. Silencing enclosure shall not add static pressure loss.
4. Double-wall construction consisting of sound absorbing insulation sandwiched between a solid metal outer skin and perforated metal inner skin.
 - a. Outer Skin Material: Aluminum Galvanized steel Powder-coated steel.
 - b. Inner Skin: Material Aluminum Galvanized steel Powder-coated steel.
 - c. Insulation Material: Mineral fiber mineral fiber wrapped in a tight woven fiberglass cloth or polymer sheet fiberfree.
5. Enclosure shall provide a physical separation between operating adjacent fans to prevent a negative performance.

S. Backdraft Damper:

1. Include each fan in the fan array with a backdraft damper at the fan [inlet] [or] [outlet] to prevent air circulation through a fan that is not operating.
 2. Open backdraft damper when fan is operating and close when fan is not operating.
 3. Design backdraft damper assembly to operate with little to no static pressure loss with fan operating throughout entire operating range from design to minimum airflow.
 - a. Add damper pressure loss shall to fan scheduled total static pressure.
 - b. If pressure loss requires a change field electrical power, air-handling unit manufacturer shall be responsible for associated cost of change.
 4. Fasten backdraft damper assembly to fan panel or enclosure using hardware designed for easy removal by maintenance personnel.
 5. Dampers shall not create measurable additional noise above the sound level of fan.
 6. Dampers shall not vibrate or rattle.
 7. Construct dampers of extruded aluminum, stainless steel, or powder-coated steel.
- T. Blank-off Panels:
1. Include one two 10 percent of Insert number blank-off panel(s) with each air-handling unit fan array for use by operators in the field to prevent air circulation through any of the fans in fan array that are not operating.
 2. Design blank-off panels for attachment to fan panels using easily removable and reusable hardware.
 3. Construct blank-offs of aluminum, stainless steel, or powder-coated steel sheets, not less than 0.07 inch Insert dimension thick.
 4. Mount fan blank-off panels in the fan inlet access section for convenient operator access and use in the future.
- U. Protective Screens:
1. Include easily removable safety screens where fan inlet and outlet are exposed to maintenance personnel, including walk-in air-handling unit plenums.
 - a. Safety screens are not required on fan inlets and outlets with backdraft dampers.
 2. Expanded-metal or wire screens, fastened to a flat bar perimeter frame.
 3. Screens shall comply with OSHA requirements.
 4. Screens and frame shall be constructed of aluminum, stainless steel, or powder-coated steel.
 5. Fasten screens to fan using removable and reusable hardware designed for easy removal by maintenance personnel.
- V. Hardware: Hex-head, high-strength carbon steel with corrosion-resistant coating 300 series stainless steel.
- W. Nameplates:
1. Construct nameplates and rotation arrows of aluminum or 300 series stainless steel.
 2. Securely fasten nameplate and rotation arrow to fan housing using pins or sheet metal screws.
 3. Locate nameplates in a highly visible location on motor side of fan.
 4. Provide the following information on nameplate: Engraved stamped labeled.
 - a. Manufacturer, address, phone number, and website address.
 - b. Manufacturer model number.
 - c. Serial number.
 - d. Manufacturing date.
 - e. Fan size.
 - f. Fan schedule equipment designation (may be listed on a separate nameplate if there is insufficient space).
 - g. Design airflow.
 - h. Design static pressure.
 - i. Design fan speed.
 - j. AMCA fan class.

k. <Insert requirement>.

X. Air-Handling Unit Factory Assembly:

1. Internal Access: Include each fan with internal access from downstream upstream sides as indicated on Drawings.
2. Removal and Replacement: Each fan wheel and motor shall be independently removable and replaceable through a removable access door installed in air-handling unit casing.
3. Stackable Fan Arrays: Construct frame work from aluminum, galvanized steel, , painted steel, or stainless steel.
4. Panel-Mounted Fan Array Supports:
 - a. Construct a freestanding and self-supporting structural framework to support each fan individually from and independent of adjacent fans.
 - b. Construct frame work from aluminum, galvanized steel, , painted steel, or stainless steel.

2.11 VIBRATION ISOLATION

A. General:

1. Provide fans inside air-handling units with base and vibration isolation indicated on Drawings.

B. Inertia Bases:

1. Description: Reinforced structural base designed for concrete infill with integral bolting provisions for fan mounting.
2. Design and Performance:
 - a. Weight of inertia base including concrete infill a minimum of 1.5 times the operating weight of fan.
 - b. Base thickness not less than 1/12 of longest span.
 - c. Minimum base thickness is as follows:
 - 1) Up to 15 HP: [6 inches] <Insert thickness>.
 - 2) 20 to 50 HP: [8 inches] <Insert thickness>.
 - 3) 60 to 75 HP: [10 inches] <Insert thickness>.
 - 4) 100 HP and Larger: [12 inches] <Insert thickness>.
3. Construction:
 - a. Base Materials: Structural carbon steel, ASTM A36/A36M structural stainless steel, ASTM A276/A276M, Type 304L structural stainless steel, ASTM A276/A276M, Type 316L.
 - 1) Carbon-Steel Finish, Mill Galvanized: Mill-galvanized carbon-steel bases with weld-damaged areas cleaned, prepared, and painted with galvanized paint after fabrication.
 - b. Base Structural Members:
 - 1) Perimeter Members: Channel I or W beam shapes tube.
 - 2) Intermediate Members (Spanning Full-Width Base): Channel I or W beam shapes tube.
 - 3) Cross Members (Spanning Intermediate Members): Angle channel tube.
 - c. Reinforcing Bars: Carbon steel, ASTM A615/A615M, sized for a maximum stress of 20,000 psi when subjected to both static and dynamic loads, and welded in place.
 - d. Floor: Design inertia base with solid floor in bottom for concrete placement after base installation. Seal to prevent leakage or seepage.
 - 1) Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 Insert coating coating, minimum (nominal) 18 gauge 16 gauge Insert value thick.
 - e. Isolator Brackets: Gusseted, height-saving brackets.

- f. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.
 4. Air-Handling Unit Factory Assembly: Install fans with inertia bases where indicated on Drawings.
 - a. Coordinate placement of inertia bases with design of air-handling unit structural base. Make provisions for attachment and support.
 - b. Coordinate inertia base mounting provisions with spring isolators.
- C. Spring Isolators:
 1. Performance:
 - a. Deflection: Minimum deflection indicated on Drawings. Use a greater deflection if required to maintain an isolator efficiency of at least **[98] <Insert number>** percent under all operating conditions encountered. Calculate isolator efficiency using actual support conditions considering the rigidity of structure.
 - b. Laterally stable freestanding open-spring mounting.
 - c. Spring diameter not less than 0.8 of compressed spring height at rated load and in the installed and operating condition.
 - d. Reserve travel to solid shall be equal to a minimum of 50 percent of rated deflection and in no case less than 25 percent of rated deflection in an installed and operating condition.
 - e. Ratio of horizontal stiffness to vertical stiffness equal to approximately one.
 - f. Design and install so that ends of springs remain parallel.
 - g. Select springs that are non-resonant with equipment related frequencies and natural frequencies of support structure.
 - h. Springs shall not take a permanent set when compressed to coil bind.
 - i. Seismic restraints to limit motion under seismic forces to [1/4 inch] **<Insert dimension>**.
 2. Construction:
 - a. Coat springs with PVC or neoprene. Color-code springs to allow positive identification after installation.
 - b. Construct baseplates, spring retainers, and other components of aluminum galvanized carbon steel stainless steel. Etch and paint aluminum components.
 - c. Use nuts, bolts, and washers and other associated hardware constructed of zinc-electroplated carbon steel stainless steel.
 - d. Isolators with integral leveling bolts.
 - e. Baseplates with holes and isolation grommets for bolting.
 - f. Bond nominal [1/4-inch-] **<Insert dimension>** thick, neoprene friction pad to baseplate.
- D. Thrust Restraints:
 1. In sets of two or more, thrust restraints shall consist of springs in series with neoprene isolators.
 2. Coordinate and select deflection of thrust restrains with equipment being restrained.
 3. Thrust restraints complete with rods and adjustment nuts, plus angle brackets and backing plates for attachment to substrate and equipment being restrained.
- E. Elastomeric Grommets:
 1. Elastomeric grommets shall be a combination of neoprene washer and bushing.
 2. Elastomer shall be 56-durometer maximum.
 3. Grommets formed to prevent bolts from directly contacting the secured item.
- F. Flexible Connections:
 1. Construct flexible connection galvanized-steel stainless steel edges firmly attached to waterproof and fire-retardant fabric.
 2. Fabric shall be [6 inches] **<Insert dimension>** wide or more.
 3. Suitable for operation in extreme temperatures encountered.
 4. NRTL listed for application and complying with NFPA 90A.

G. Air-Handling Unit Factory Assembly:

1. Use precompression -type height-saving brackets with isolators having [2-1/2 inch] **<Insert dimension>** deflection or greater, to limit exposed bolt length.
2. Install spring isolators plumb and adjust isolators that are not plumb under operating conditions to make plumb.
3. Adjust isolators to prevent stress transfer to equipment.
4. Verify that installed isolators and mounting systems permit equipment motion in all directions.
5. Restraint fans with isolated thrust resistors to limit displacement to [1/4 inch] **<Insert dimension>**. Design for the maximum lateral thrust the fan can develop.
6. Adjust or include additional resilient restraints to flexibly limit fan lateral motion to [1/4 inch] **<Insert dimension>** during startup and operation of equipment.
7. Anchor restraints to fixed supports having a stiffness greater than the thrust encountered.
8. Include at least [2-inch] **<Insert dimension>** operating clearance between fan bases and walking surface of air-handling unit floor. Before startup, clean out foreign matter between bases and equipment to prevent short circuit.
9. Flexible Connections:
 - a. Install flexible connections at connections to fans.
 - b. Install flexible connections in accordance with SMACNA standards and manufacturer's written instructions.
 - c. Make fabric joints on the flat run, not the corners, with overlap to provide an area sufficient to make a positive seal.
 - d. Apply adhesive between fabric layers.
 - e. Attach connections using screws or bolts.
 - f. Reinforce fabric if required to keep fabric from collapsing and impacting airflow into fan.

2.12 HYDRONIC COILS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
1. Aerofin.
 2. Coilmaster Corporation.
 3. Modine Manufacturing Company.
 4. Super Radiator Coils.
 5. Insert manufacturer's name.
- B. Sourcing Option: In lieu of sourcing hydronic coils from a specialty coil manufacturer, air-handling unit manufacturer has option to furnish in-house hydronic coils that achieve equal or better performance while complying with other requirements indicated.
- C. General: Provide air-handling units with hydronic coils where indicated on Drawings.
- D. Description: Plate fin coils constructed of staggered tubes mechanically expanded into continuous collars that are die formed into plate fins.
- E. Design and Performance:
1. Capacities, face area, and number of rows indicated on Drawings are minimum acceptable.
 2. Air pressure drop, water pressure drop, fin spacing, and face velocity indicated on Drawings are the maximum acceptable.
 3. Coils shall be counterflow design, air to fluid. Fluid supply shall enter air leaving side of coil and exit air entering side.
 4. Design coils to be drainable.
 - a. Coils shall have all circuits drainable when coils are installed in horizontal position and level.

- b. Coil supply [**and return**] header shall be furnished with a drain connection at lowest point on header.
 5. Design coils to be self-venting.
 - a. Supply connection near bottom of supply header.
 - b. Return connection near top of return header.
 - c. Furnish coil return [**and supply**] header with a vent connection at highest point on header.
 6. Coils supply and return piping connections on same end of coil.
 7. Coils shall be rated for system operating pressures and temperatures encountered by installation, but not less than [200 psig] [300 psig] **<Insert pressure>**.
 8. Coil selection criteria, unless otherwise indicated on Drawings, are as follows:
 - a. Face Velocity: Maximum of [500 fpm] **<Insert value>**.
 - b. Fluid Tube Velocity (at Design Flow Rate):
 - 1) Maximum: [6 fps] **<Insert velocity>**.
 - 2) Minimum: [3 fps] **<Insert velocity>**.
 - c. Fluid Header Velocity: Maximum of [6 fps] **<Insert velocity>**.
 - d. Fin Height: Maximum of [48 inches] **<Insert dimension>**.
 - e. Fin Spacing: Maximum of [12 fins per inch] **<Insert spacing>**.
 9. Cooling coils shall have no moisture carryover at design conditions. Install moisture eliminators on discharge face of coil if it is necessary to eliminate moisture carryover.
- F. Casing and Tube Sheets:
 1. Depth: Extend coil casing and tube sheets a minimum of [1/2 inch] **<Insert dimension>** beyond face of fins on both entering and leaving side.
 2. Casing and Tube Sheet Materials:
 - a. Cooling Coils: Stainless steel, ASTM A240/A240M or ASTM A480/A480M, Type 304L Type 316L, No. 2D finish.
 - b. Heating Coils:
 - 1) Stainless steel, ASTM A240/A240M or ASTM A480/A480M, Type 304L Type 316L, No. 2D finish.
 - 2) Galvanized steel, ASTM A653/A653M, G90 coating.
 3. Top and Bottom Casings:
 - a. Flange face minimum of [1-1/2 inches] **<Insert dimension>**; double flange edge for rigidity and ease of removal with secondary flange face minimum of [1/2 inch] **<Insert dimension>**.
 - b. Thickness:
 - 1) Coils with Fin Length of up to 72 Inches Insert dimension: Minimum of 16 gauge 14 gauge 12 gauge thick.
 - 2) Coils with Fin Length Exceeding 72 Inches Insert dimension: Minimum of 16 gauge 14 gauge 12 gauge thick.
 4. End Tube Sheets:
 - a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
 - b. Flange face minimum of [1-1/2 inches] **<Insert dimension>**.
 - c. Thickness: Minimum of 16 gauge 14 gauge 12 gauge thick.
 5. Intermediate Tube Sheets:
 - a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
 - b. Space intermediate tube sheets a maximum of [48 inches] **<Insert dimension>** o.c. and locate to provide equal spacing between tube sheet across coil tube length.
 - c. Flange face minimum of [1/2 inch] **<Insert dimension>**.

- d. Thickness: Minimum of [16 gauge] <Insert thickness> thick.
 6. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.
- G. Fins:
1. Materials:
 - a. Aluminum: 0.0060 inch 0.0075 inch 0.0095 inch Insert dimension thick.
 - b. Copper: 0.0060 inch 0.0075 inch 0.0095 inch Insert dimension thick.
 - c. 90/10 Cupronickel: 0.0060 inch 0.0075 inch 0.0095 inch Insert dimension thick.
 2. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
 3. Fin Configuration: Flat face fins without ripples Flat face or enhanced ripple fins as required by performance.
- H. Headers:
1. Construct header of seamless copper, ASTM B75/B75M drawn temper of diameter and wall thickness based on coil size, flow rate, design pressure, design temperature, and circuiting.
 2. Tube-to Header Connections: Tube-to-header holes shall intrude inward so landed surface area is three times the core tube thickness, to provide enhanced header to tube joint integrity. Tubes shall evenly extend within the ID of the header no more than 0.12 inch.
 3. Header Top and Bottom Caps: End caps shall be die-formed and installed on the ID of header such that the landed surface area is three times the header wall thickness.
 4. Drains: Include low point of supply supply and return header with a NPS 1/2 Insert pipe size drain connection. Extend copper or red brass carbon-steel stainless steel Insert material pipe through air-handling unit casing and terminate end with male national pipe threads (MNPT). Pipe shall be threaded on both ends to facilitate easy field removal and replacement.
 5. Vents: Include high point of return supply and return header with a NPS 1/2 Insert pipe size vent connection. Extend copper or red brass carbon-steel stainless steel Insert material pipe through air-handling unit casing and terminate end with MNPT. Pipe shall be threaded on both ends to facilitate easy field removal and replacement.
 6. Supply and Return Connections:
 - a. Terminate ends with MNPT.
 - b. Connections to header shall be either copper tube with brazed ASME B16.18 threaded male adapters or red brass carbon-steel stainless steel Insert material pipe with machine-threaded MNPT connections. Pipe shall extend through air-handling unit casing and be threaded on both ends to facilitate easy field removal and replacement.
 - c. Connections [NPS 2-1/2] <Insert pipe size> and larger shall have a bronze ASME 16.24 threaded flanges attached to threaded connections to provide for a flanged field connection. Select flange class, Class 150 or Class 300, for system pressure and temperature encountered.
 7. Protect openings of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into the coil.
- I. Tubes:
1. Material: Copper, ASTM B75/B75M annealed temper or ASTM B280 drawn temper; **[90/10 cupronickel alloy, ASTM B122/B122M]**.
 2. Tube Nominal Diameter: 1/2 or 5/8 inch before expanding, selected to provide performance indicated.
 3. Tube Nominal Wall Thickness: As required by performance, minimum of 0.020 inch 0.025 inch 0.035 inch Insert dimension thick.
- J. Tube Return Bends: 180-degree bends brazed to tubes; material[, **wall thickness,**] and nominal diameter to match tubes.

1. Tube Return Bend Nominal Wall Thickness: As required by performance, minimum of 0.020 inch 0.025 inch 0.035 inch Insert dimension thick.
- K. Brazing: High-temperature brazing alloy with not less than 5 percent silver when brazing like non-ferrous materials together and more than 30 percent silver when brazing ferrous to non-ferrous materials.
- L. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for coils requiring a corrosion-resistant coating.
- M. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 304 Type 316 stainless steel.
- N. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:
 1. Manufacturer name, address, telephone number, and website address.
 2. Manufacturer model number.
 3. Serial number.
 4. Manufacturing date.
 5. Coil identification (indicated on Drawings).
 6. Coil fin length.
 7. Coil fin height.
 8. Coil weight with fluid/without fluid.
 9. Coil casing material and thickness.
 10. Coil fin material and thickness.
 11. Coil tube material and thickness.
 12. Coil header material and thickness.
 13. **<Insert requirements>**.
- O. Cleaning: Residual manufacturing oils and solid contaminants shall be removed internally and externally by completely submersing the coil in an environmentally acceptable degreasing solution that is chemically compatible with the coil material.
- P. Air-Handling Unit Factory Assembly:
 1. Coil Connections: Extend each coil connection through casing access panel and terminate connections, approximately [4 inches] **<Insert dimension>** beyond exterior face of access panel, and seal each penetration as indicated. Casing access panels shall be removed and reinstalled with coils installed inside air-handling units.
 2. Internal Access: Include each coil with internal access from downstream upstream sides as indicated on Drawings.
 3. Removal and Replacement: Each coil shall be independently removable and replaceable through a removable access panel installed in air-handling unit casing.
 4. Supports for Coils:
 - a. Construct a freestanding and self-supporting structural framework to support each coil individually from and independent of adjacent coils.
 - b. Construct framework for cooling coils, from aluminum or stainless steel[**structural shapes**].
 - c. Construct frame work for heating coils from aluminum[, **galvanized steel**,] or stainless steel[**structural shapes**].

2.13 DRAIN PANS

- A. General:
 1. Include a drain pan for each cooling and **heat recovery** coil and at other locations indicated.
 2. Continuously weld drain pan seams, joints, and mitered corners to make the assembled drain pan watertight.
 3. Drain pans shall be located under the entire coil and provide full coil coverage including coil return bends and headers.

4. Slope drain pans in multiple directions toward low point drain connection at a uniform slope of at least 1/2 percent from high point to low point.
5. Include stainless steel blank-offs to prevent air from bypassing around coil.

B. Intermediate Drain Pans:

1. Where multiple individual horizontally mounted coils are vertically stacked to make a coil bank, install intermediate drain pans under each stacked coil in the coil bank.
2. Material: Type 304L Type 316L 300 series stainless steel ASTM A240/A240M or ASTM A480/A480M, a minimum of 16 gauge Insert value thick.
3. Minimum Depth: 1.0 inch 1.5 inches Insert dimension.
4. Extend drain pan beyond air entering face of coil casing at least [3 inches] **<Insert distance>**.
5. Extend drain pan beyond air leaving face of coil casing at least [6 inches] **<Insert distance>**.
 - a. Where moisture eliminators are required to prevent moisture carryover, extend drain pan beyond leaving face of moisture eliminator in lieu of leaving face of coil.
6. Drain Pan Connection:
 - a. Stainless steel threaded coupling welded to underside of drain pan at lowest point.
 - b. Minimum Nominal Connection Size: NPS 1 NPS 1.5 NPS 2 Insert pipe size.
7. Drain Pipe:
 - a. Air-handling unit manufacturer to connect full-size drain pipe to each drain pan connection. Option to use one of following pipe materials:
 - 1) Copper tube with a bronze threaded male adapter, brazed or solder to end.
 - 2) Aluminum pipe with threaded MNPT ends.
 - 3) Stainless steel pipe with threaded MNPT ends.
 - b. Extend drain pipe to top of drain pan immediately below.
 - c. Include a removable stainless steel support to secure bottom of drain pipe from drain pan below to prevent lateral movement.
 - d. In applications where multiple drain pans are stacked, align stacked drains pan connections and pipes for clear vertical flow.

C. Bottom Drain Pans:

1. Mounting Location, Recessed in Floor: Air-handling unit manufacturer has option to recess bottom drain pan into the floor or install drain pan above air-handling unit floor walking surface.
2. Grating: Install removable stainless steel grating on top of drain pan.
3. Double-Wall Construction: Double-wall sheet with space between walls filled with [1-inch] **<Insert thickness>** insulation.
4. Material: Type 304L Type 316L 300 series stainless steel ASTM A240/A240M or ASTM A480/A480M, a minimum of 16 gauge Insert value thick.
5. Minimum Depth: [1.5 inches] **<Insert depth>**.
6. Extend drain pan beyond air entering face of coil casing at least [3 inches] **<Insert distance>**.
7. Extend drain pan beyond air leaving face of coil casing at least [12 inches] **<Insert distance>**.
 - a. Where moisture eliminators are required to prevent moisture carryover, extend drain pan beyond leaving face of moisture eliminator in lieu of the leaving face of coil.
8. Drain Pan Connection:
 - a. Stainless steel threaded half-coupling welded to lowest point of drain pan.
 - b. Location: One end Both ends See Drawings Insert requirement.
 - c. Minimum Nominal Connection Size: NPS 1 NPS 1.5 NPS 2 Insert pipe size.
9. Drain Pipe:
 - a. Air-handling unit manufacturer to connect full size drain pipe to each drain pan connection. Option to use one of following pipe materials:
 - 1) Copper tube with threaded male adapter, brazed or soldered to ends.

- 2) Aluminum pipe with threaded MNPT ends.
 - 3) Stainless steel pipe with threaded MNPT ends.
- b. Extend drain pipe and terminate [3 inches] <Insert distance> beyond exterior face of casing.

2.14 PLEATED PANEL FILTERS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
1. AAF International.
 2. Camfil Farr Inc.
 3. Flanders Corporation.
 4. Koch Filter Corporation.
 5. Or Equal.
- B. Source Limitations: Obtain filters from single source from single manufacturer.
- C. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters.
- D. Performance:
1. Filtration Efficiency, ASHRAE 52.2 MERV Rating: 8 8A 9 9A See Drawings.
 2. Energy Cost Index: Five star rating.
 3. Initial Air Pressure Drop: With face velocity of 500 fpm, clean filter pressure drop shall not exceed the following:
 - a. MERV 8 and MERV 8A:
 - 1) Depth 1 Inch: 0.23 inch wg.
 - 2) Depth 2 Inches: 0.31 inch wg.
 - 3) Depth 4 Inches: 0.27 inch wg.
 - b. MERV 14 and MERV 14A:
 - 1) Depth 12 Inches: 0.67 inch wg.
 4. Manufacturer-Recommended Final Air Pressure Drop: [1.0 inch wg] <Insert pressure drop>.
 5. Pressure Differential without Failure: [2 inches wg] <Insert pressure drop>.
 6. Temperature Rating: [200 deg F] <Insert temperature>.
- E. Certification:
1. AHRI: Tolerances in accordance with AHRI 850 (I-P) and AHRI 851 (SI).
 2. ASHRAE: Tested and rated in accordance with ASHRAE 52.2.
 3. UL: UL 900 listed.
- F. Size:
1. Nominal size of individual filters indicated on Drawings:
 2. Actual Filter Size: Suitable for installation in an industry-standard filter holding frame.
- G. Filter Media Surface Area: Each filter shall contain the following minimum media surface area for a filter with a nominal 24-by-24-inch face:
1. Depth 1 Inch: 9.8 sq. ft..
 2. Depth 2 Inches: 17.3 sq. ft..
 3. Depth 4 Inches: 27.7 sq. ft..

H. Construction:

1. Media: Glass or Cotton and synthetic blend of fibers arranged in a series of pleats attached to and supported by a corrosion-resistant welded-wire grid. Coat media with an antimicrobial agent.
2. Filter Media Casing: High wet strength (28-point) beverage board that is bonded around the periphery to eliminate air bypass.
 - a. Diagonal support members across upstream and downstream filter face constructed of same material as casing shall ensure pleat spacing and stability.
3. Adhesive: Fire-retardant bonding adhesive where bonding media to casing.

2.15 ASHRAE-RATED FILTER HOLDING FRAMES

A. Filter Holding Frames for ASHRAE-Rated Filters:

1. Fabricate filter holding frames with mitered corners and reinforce frame to maintain a durable, rugged, true square shape.
2. Construct frames of galvanized stainless steel. Use stainless steel frames in applications exposed to corrosive airstreams.
3. For applications with pre-filter and final filters sharing the same filter holding frame, frames shall be suitable for supporting and holding both pre-filter and final filters in frame with both filters serviceable from upstream (entering air) side.
4. Frame Depth: At least [2.75 inches] **<Insert dimension>**.
5. Gaskets: Continuous, suitable for same operating temperature as filters.
6. Filter Clips: Each filter holding frame with spring clip fasteners at each corner. Spring clips shall allow filters to be removed and replaced without use of tools.
7. Frames shall be industry-standard size to provide interchangeability of filters from other manufacturers.

B. Air-Handling Unit Factory Installation:

1. Air-handling unit manufacturer shall furnish filters and provide filter holding frames, retaining clips, and filter support structures.
2. Furnish filter quantity, size, type, and performance indicated on Drawings.
3. Install filter frames in a flat vertical position for horizontal airflow.
4. Install holding frames in accordance with manufacturer's written instructions and to prevent passage of unfiltered air. Include additional gaskets as necessary.
5. Secure individual holding frames together to build a multiple filter bank.
6. Construct aluminum galvanized-steel stainless steel support structure to hold frames and filters.
 - a. Design support structure for maximum system operating pressures encountered equal to fan shutoff pressure.
 - b. Design and fabricate support structure to limit deflection across filter bank to 1/360 of the span when subjected to a [200-lb] **<Insert value>** lateral force applied at any point on the filter holding frame assembly.

2.16 FILTER GAUGES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the following:

1. Gauge: **<Insert manufacturer's name; product name or designation>**.
2. Vent Valves: **<Insert manufacturer's name; product name or designation>**.
3. Static Pressure Sensors: **<Insert manufacturer's name; product name or designation>**.
4. Tubing Compression Fittings: **<Insert manufacturer and product name or designation>**.

B. Provide a gauge to indicate pressure differential between entering and leaving side of each filter bank. Panel filter bank separate from cartridge filter bank.

1. Where multiple filters share a common frame, include a separate gauge for each filter bank.

2. Include a metal spacer constructed of same material as filter frame for one of the filters installed in filter bank to accommodate pressure differential measure across both upstream and downstream filters.
- C. Gauge shall have a nominal 4-inch- diameter face.
- D. Select range of gauge to be approximately twice three times Insert range the dirty filter pressure drop.
- E. Provide each gauge with vent valves to allow for re-zeroing the gauge without removing tubing connections.
- F. Include static pressure sensors on entering and leaving side of each filter bank.
- G. Air-Handling Unit Factory Assembly:
 1. Mount each filter gauge on exterior surface of unit casing near associated filter sections.
 2. Mount center of gauges [60 inches] <Insert distance> above bottom of air-handling unit structural base.
 3. Connect static pressure sensors to filter gauges using aluminum copper stainless steel tubing and compression type fittings.
 4. Support tubing at intervals not greater than [60 inches] <Insert distance> o.c.

2.17 AUTOMATIC DAMPERS

- A. General: Provide air-handling units with automatic dampers where indicated on Drawings.
 1. Unless otherwise indicated, use parallel-blade configuration for two-position control, for equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
 2. Factory assemble multiple damper sections to provide a single damper assembly of size required by application.
 3. Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.
- B. Rectangular Dampers with Aluminum Blades:
 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. American Warming and Ventilating (AWV); Mestek, Inc.
 - b. Greenheck Fan Corporation.
 - c. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 - d. TAMCO (T. A. Morrison & Co. Inc.).
 - e. Insert manufacturer's name.
 2. Source Limitations: Obtain dampers from single source from single manufacturer.
 3. Performance:
 - a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
 - b. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, figure 5.3.
 - c. Velocity: Up to 4000 fpm 6000 fpm.
 - d. Temperature: Minus 40 to plus 185 deg F.
 - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
 - f. Damper shall have AMCA seal for both air leakage and air performance.
 4. Construction:

- a. Frame:
 - 1) Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch thick.
 - 2) Hat-shaped channel with integral flange(s). Flange mating face shall be a minimum of 1 inch.
 - 3) Width not less than 5 inches.
 - b. Blades:
 - 1) Hollow, airfoil, extruded aluminum.
 - 2) Parallel- or opposed-blade configuration as required by application.
 - 3) Material: ASTM B211, Alloy 6063 T5 aluminum, 0.07 inch thick.
 - 4) Width not to exceed 6 inches.
 - 5) Length as required by close-off pressure, not to exceed 48 inches.
 - c. Seals:
 - 1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
 - 2) Jamb: Stainless steel, compression type[; **or replaceable, mechanically attached extruded silicone**].
 - d. Axles: 0.5-inch- diameter plated stainless steel, mechanically attached to blades.
 - e. Bearings:
 - 1) Molded synthetic or stainless steel sleeve mounted in frame.
 - 2) Where blade axles are installed in vertical position, include thrust bearings.
 - f. Linkage:
 - 1) Concealed in frame.
 - 2) Constructed of aluminum and plated stainless steel.
 - 3) Hardware: Stainless steel.
 - g. Additional Corrosion Protection for Corrosive Environments:
 - 1) Include anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch thick.
 - 2) Axles, damper linkage, and hardware shall be constructed of Type 316L grade stainless steel.
5. Airflow Measurement: Where indicated, include damper assembly with integral airflow monitoring.
- a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
 - 1) Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 - 2) Insert manufacturer's name.
 - b. Source Limitations: Obtain damper applications from single source from single manufacturer.
 - c. Zero- to 10-V dc or 4- to 20-mA scaled output signal for remote monitoring of actual airflow.
 - d. Accuracy shall be within 5 percent of actual flow rate between the range of minimum and design airflow. For applications with a large variation in range between the minimum and design airflow, configure damper sections and flow measurement assembly as required to comply with stated accuracy over the entire modulating range.
 - e. Include a straightening device as part of flow measurement assembly to achieve the specified accuracy with configuration indicated.
 - f. Suitable for operation in untreated and unfiltered air.
 - g. Include temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
 - h. Include automatic zeroing feature.

6. Airflow Control: Where indicated, provide damper assembly with integral airflow measurement and control.
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 - 2) Insert manufacturer's name.
 - b. Source Limitations: Obtain damper assembly from single source from single manufacturer.
 - c. A factory-furnished and -calibrated controller shall be programmed, in nonvolatile EPROM, with application-specific airflow set point and range.
 - d. Controller and actuator shall communicate to control the desired airflow.
 - e. Controller shall receive a 0- to 10-V dc input signal and report a 0- to 20-mA output signal that is proportional to airflow.
 - f. Airflow measurement and control range shall be suitable for operation between 150 to 2000 fpm.
 - g. Ambient Operating Temperature Range: Minus 40 to plus 140 deg F.
 - h. Ambient Operating Humidity Range: 5 to 95 percent relative humidity, noncondensing.
 - i. Provide unit with control transformer rated for not less than 85 VA. Include transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
 - j. Include screw terminals for interface to field wiring.
 - k. Factory mount electronics within a NEMA 250, Type 1 painted steel enclosure.
- C. Rectangular Dampers with Insulated Aluminum Blades:
 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. American Warming and Ventilating (AWV); Mestek, Inc.
 - b. Greenheck Fan Corporation.
 - c. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 - d. TAMCO (T. A. Morrison & Co. Inc.).
 - e. Insert manufacturer's name.
 2. Source Limitations: Obtain dampers from single source from single manufacturer.
 3. General: Unless otherwise indicated on Drawings, install insulated aluminum blade dampers in applications where dampers close to outdoors.
 4. Performance:
 - a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure and shall not exceed 4.9 cfm/sq. ft. against 4-inch wg differential static pressure at minus 40 deg F.
 - b. Pressure Drop: 0.1 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, figure 5.3.
 - c. Velocity: Up to 4000 fpm.
 - d. Temperature: Minus 100 to plus 185 deg F.
 - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
 - f. Damper shall have AMCA seal for both air leakage and air performance.
 5. Construction:
 - a. Frame:
 - 1) Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.08 inch thick.
 - 2) C-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch.
 - 3) Width not less than 4 inches.

- 4) Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts.
 - b. Blades:
 - 1) Hollow shaped, extruded aluminum.
 - 2) Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.
 - 3) Parallel- or opposed-blade configuration as required by application.
 - 4) Material: ASTM B211, Alloy 6063 T5 aluminum, 0.08 inch thick.
 - 5) Width not to exceed 6 inches.
 - 6) Length as required by close-off pressure, not to exceed 48 inches.
 - c. Seals: Blade and frame seals shall be of flexible silicone and secured in an integral slot within the aluminum extrusions. [**Option to use stainless steel compression-type frame seals.**]
 - d. Axles: 0.44-inch- diameter plated stainless steel, mechanically attached to blades.
 - e. Bearings:
 - 1) Bearings shall be composed of a celcon inner bearing fixed to axle, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
 - 2) Where blade axles are installed in vertical position, include thrust bearings.
 - f. Linkage:
 - 1) Concealed in frame.
 - 2) Constructed of aluminum and plated stainless steel.
 - 3) Hardware: Stainless steel.
 - g. Additional Corrosion Protection for Corrosive Environments:
 - 1) Include anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch thick.
 - 2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.
- D. Damper Actuators:
1. General:
 - a. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which damper is subjected.
 - b. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.
 - c. Total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.
 - d. Include one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
 - e. Avoid use of excessively oversized actuators, which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
 - f. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
 - g. Include mounting hardware and linkages for connecting actuator to damper.
 - h. Select actuators to fail in desired position in the event of a power failure.
 2. Type: Motor operated, with or without gears, electric and electronic.
 3. Voltage:
 - a. See Drawings Voltage selection is delegated to professional designing control system 24 V 120 V.

- b. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
 - c. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.
 4. Construction:
 - a. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
 - b. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
 - c. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
 5. Field Adjustment:
 - a. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
 - b. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when actuator is not powered.
 6. Two-Position Actuators: Single direction, spring return, or reversing type.
 7. Modulating Actuators:
 - a. Capable of stopping at all points across full range, and starting in either direction from any point in range.
 - b. Control Input Signal:
 - 1) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 0- to 10- 2- to 10-V dc 4- to 20-mA signals.
 - 2) Pulse-Width Modulation (PWM): Actuator drives to a specified position in accordance with a pulse duration (length) of signal from a dry-contact closure, triac sink, or source controller.
 - 3) Programmable Multifunction:
 - a) Control input, position feedback, and running time shall be factory or field programmable.
 - b) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
 - c) Service data, including at a minimum, number of hours powered, and number of hours in motion.
 8. Position Feedback:
 - a. Equip Where indicated, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open close position.
 - b. Include a position indicator and graduated scale on each actuator indicating open and closed travel limits.
 9. Fail-Safe:
 - a. Where indicated, provide actuator to fail to an end position.
 - b. Internal spring return mechanism to drive-controlled device to an end position (open or close) on loss of power.
 - c. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.
 10. Integral Overload Protection:
 - a. Provide against overload throughout the entire operating range in both directions.
 - b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
 11. Damper Attachment:

- a. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
 - b. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
 - c. Bolt and setscrew method of attachment is acceptable only if included with at least two points of attachment.
12. Temperature and Humidity:
- a. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of [minus 20 to plus 120 deg F] **<Insert temperature range>**.
 - b. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from **[5 to 95] <Insert numbers>** percent relative humidity, noncondensing.
13. Enclosure:
- a. Suitable for ambient conditions encountered by application.
 - b. Provide actuator enclosure with a heater and controller where required by application.
 - c. NEMA 250, Type 2 for all applications except **<Insert applications>**.
 - d. NEMA 250, Type 4 or Type 4X for **<Insert applications>** applications.
14. Stroke Time: Select operating speed to be compatible with equipment and system operation.
- a. Operate damper from fully closed to fully open within 15 60 75 90 150 Insert number seconds.
 - b. Actuators operating in smoke-control systems shall comply with governing code and NFPA requirements.
15. Sound:
- a. Spring Return: 62 dBA.
 - b. Non-Spring Return: 45 dBA.

2.18 MANUAL BALANCING DAMPERS

- A. General: Air-handling unit manufacturer shall furnish and factory install manual balancing dampers inside air-handling units where indicated on Drawings.
- B. Rectangular Manual Balancing Dampers with Aluminum Airfoil Blades:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Greenheck Fan Corporation.
 - b. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 - c. TAMCO (T. A. Morrison & Co. Inc.).
 - d. Insert manufacturer's name.
 2. Source Limitations: Obtain dampers from single source from single manufacturer.
 3. Performance:
 - a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
 - b. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, figure 5.3.
 - c. Velocity: Up to 6000 fpm.
 - d. Temperature: Minus 40 to plus 185 deg F.
 - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
 - f. Damper shall have AMCA seal for both air leakage and air performance.

4. Construction:
 - a. Frame:
 - 1) Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch thick.
 - 2) Hat-shaped channel with integral flange(s). Flange mating face shall be a minimum of 1 inch.
 - 3) Width not less than 5 inches.
 - b. Blades:
 - 1) Hollow, airfoil, extruded aluminum.
 - 2) Parallel- or opposed-blade configuration as required by application.
 - 3) Material: ASTM B211, Alloy 6063 T5 aluminum, 0.07 inch thick.
 - 4) Width not to exceed 6 inches.
 - 5) Length as required by close-off pressure, not to exceed 48 inches.
 - c. Seals:
 - 1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
 - 2) Jamb: Stainless steel, compression type.
 - d. Axles: 0.5-inch- diameter plated stainless steel, mechanically attached to blades.
 - e. Bearings:
 - 1) Molded synthetic or stainless steel sleeve mounted in frame.
 - 2) Where blade axles are installed in vertical position, include thrust bearings.
 - f. Linkage:
 - 1) Concealed in frame.
 - 2) Constructed of aluminum and plated stainless steel.
 - 3) Hardware: Stainless steel.
 - g. Locking Regulator:
 - 1) Aluminum or stainless steel standoff with locking regulator mounted to frame in an accessible location for manual adjustment of damper blades.
 - h. Additional Corrosion Protection for Corrosive Environments:
 - 1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch thick.
 - 2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

2.19 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 1. Dynasonics.
 2. IAC Acoustics.
 3. Price Industries Limited.
 4. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
 5. Vibro-Acoustics.
 6. Insert manufacturer's name.
- B. Duct Silencer Sourcing Option: In lieu of sourcing duct silencers from a specialty duct silencer manufacturer, air-handling unit manufacturer has option to furnish in-house silencers that achieve equal or better performance while complying with other requirements indicated.

1. Full-height duct silencers baffles shall span from floor to roof of air-handling unit air tunnel and consist of multiple baffles aligned to fill the entire cross-sectional area of air-handling unit air tunnel. In this alternative, the air-handling unit casing shall serve as the duct silencer casing.
- C. General: Air-handling unit manufacturer shall furnish and install duct silencers and associated support structures inside air-handling units where indicated on Drawings.
1. Unless otherwise indicated on Drawings, select face area of silencers to fill the entire cross-sectional area of air-handling unit air tunnel.
 2. Silencer Type: **[Dissipative] [Reactive (packless)] [Type, either dissipative or reactive (packless), indicated on Drawings]**.
 3. Factory fabricated.
 4. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials with flame-spread index not exceeding 25 and smoke-developed index not exceeding 50; ASTM E84.
 5. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. Ratings and Performance:
1. Duct silencer manufacturer shall publish performance for dynamic insertion loss (DIL), self-noise power levels, and airflow static pressure loss based on results of performance testing indicated.
 2. Duct silencer manufacturer shall test duct silencers in accordance with ASTM E477 in a qualified nationally recognized independent testing laboratory or manufacturer's National Voluntary Lab Accreditation Program accredited laboratory.
 - a. Conduct tests with air flowing through duct silencers at not less than three different flow rates and with no airflow.
 - b. Test methods shall eliminate effects due to end reflection, vibration, flanking transmission, and standing waves in the test chamber.
 3. DIL is not less than values indicated on Drawings.
 4. Silencer self-generated noise shall not increase system sound level.
 5. Static pressure loss not to exceed values indicated on Drawings.
 6. Structural Performance:
 - a. Design casing for differential air pressure of 8 inches wg between.
 - b. Reinforce duct silencer casing to limit deflection to 1/200 of span.
- E. Construction: Fabricate rectangular silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for individual unit assemblies.
1. Casing:
 - a. Unless otherwise indicated, construct outer casing in accordance with ASHRAE and SMACNA standards for construction of high-pressure rectangular ductwork.
 - b. Casing seams and joints shall be lock formed and mastic filled, or continuously welded.
 - c. Materials and Thickness:
 - 1) Aluminum, ASTM B209 Alloy 3003-1114, Smooth Finish:
 - a) Outer Casing: Solid, minimum 0.040 inch 0.063 inch Insert dimension thick.
 - b) Baffles: Perforated, minimum 0.032 inch 0.040 inch Insert dimension thick for sizes through 24 inches Insert dimension tall and 0.040 inch 0.063 inch Insert dimension thick for larger sizes.
 - 2) Galvanized Steel, ASTM A653/A653M, G60 G90 Finish:
 - a) Outer Casing: Solid, minimum 20 gauge 22 gauge Insert thickness thick.
 - b) Baffles: Perforated, minimum 24 gauge 26 gauge Insert thickness for sizes through 24 inches Insert dimension tall and 20 gauge 22 gauge Insert thickness for larger sizes.

- 3) Stainless Steel, ASTM A240/A240M or ASTM A480/A480M:
 - a) Outer Casing: Solid, minimum 20 gauge 22 gauge Insert thickness thick.
 - b) Baffles: Perforated, minimum 24 gauge 26 gauge Insert thickness for sizes through 24 inches Insert dimension tall and 20 gauge 22 gauge Insert thickness for larger sizes.
 - d. Duct Silencer Material Applications:
 - 1) Exhaust Air, General: Aluminum Galvanized steel Type 304L stainless steel Type 316L stainless steel.
 - 2) Exhaust Air, Hazardous: Aluminum Galvanized steel Type 304L stainless steel Type 316L stainless steel.
 - 3) Mixed Air: Aluminum Galvanized steel Type 304L stainless steel Type 316L stainless steel.
 - 4) Outdoor Air: Aluminum Galvanized steel Type 304L stainless steel Type 304 stainless steel.
 - 5) Return Air: Aluminum Galvanized steel Type 304L stainless steel Type 316L stainless steel.
 - 6) Supply Air: Aluminum Galvanized steel Type 304L stainless steel Type 316L stainless steel.
 - 7) **<Insert material application>**.
 2. Dissipative-Type Duct Silencer Fill Materials:
 - a. Inert, vermin-proof, and moisture-proof inorganic mineral or glass fiber of a density sufficient to obtain the acoustic performance indicated. Fiber-free fill materials are an acceptable alternative to fiber fill materials if complying with other requirements.
 - b. Pack fill under not less than [5] **<Insert number>** percent compression.
 - c. Fill material and coverings shall not exceed the following values when tested in accordance with ASTM E84, NFPA 255, and UL 723:
 - 1) Flame-Spread Index: 25.
 - 2) Smoke-Developed Index: 50.
 - 3) Fuel Contribution: 20.
 - d. Protective Coverings for Fiber Fill Materials:
 - 1) Except for silencers used in exhaust applications completely cover silencer fiber fill materials with a protective covering, such as a tightly woven fiberglass fabric, to prevent particle contamination of airstream without degrading silencer acoustical performance.
 - 2) For silencers located in airstreams filtered by absolute filters and where located in potentially hazardous exhaust airstreams, enclose the fiber fill material in a polymer sheeting to prevent contaminating air stream without impacting air cleanliness and hygiene. Offset polymer sheeting with honeycomb standoff to prevent polymer sheeting from coming in direct contact with perforated baffles.
 3. Reactive-Type (Packless) Duct Silencer Baffles: Controlled impedance membranes and broadly tuned resonators without absorptive fill material.
 4. Removable Baffles: Design and construct baffles to be easily removable for purposes of cleaning and replacement.
- F. Factory Assembly:
1. Install duct silencers in correct direction with respect to airflow.
 2. Manufacturer's written installation instructions shall not be compromised.
 3. Seal penetrations through duct silencer baffles using a sealant.
 4. Install duct silencers with baffles oriented in the vertical position.
 5. Duct silencer banks consisting of multiple individual duct silencers shall be as follows:
 - a. Structurally reinforced to support loading and limit deflection to 1/200 of span.

- b. Provided with a continuous nosing to cover all joints of adjoining duct silencers. Nosing shall be constructed of same material as duct silencers and attached by friction fit, crimping, or button punch.
- c. Fastened together using zinc-plated stainless steel sheet metal screws that are spaced at not more than 6 inches Insert dimension apart, starting at corners.

G. Cleaning:

1. After assembly, clean duct silencers with HEPA-filtered vacuum machines and then wipe all surfaces with a cleaning agent, using clean rags.

2.20 DRAINS

A. Floor Drains:

1. Drain Body: Fabricate floor drain body of NPS 4 or larger aluminum or stainless pipe and weld a plate of same material to the bottom. Option to fabricate an aluminum or stainless steel rectangular box drain at least 4 by 4 inches of material at least 0.1 inch thick.
2. Drain Connection: Weld a nominal NPS 2 Insert pipe size half coupling in side of drain body located within 1 inch from bottom.
3. Drain Cover: Perforated plate, at least 0.1 inch thick, or grating, fabricated from aluminum or stainless steel. Drain cover shall be supported and secured in place by drain body, but not fastened to drain body with fasteners.
4. Fluid Seal: Seal Weld floor drain body to air-handling unit floor for a watertight installation.
5. Mounting: Recess floor drain body into structural base. Top of floor drain to be slightly recessed below air-handling unit finished floor for unobstructed gravity flow from floor into drain.
6. Application:
 - a. Install floor drains in air-handling unit floors at locations indicated on Drawings.

2.21 FACTORY ASSEMBLED ELECTRICAL

A. Factory install UV-C and switches, service light fixtures and switches, receptacles for each air-handling unit.

1. Locate in a convenient and field-accessible location.
2. Installation shall comply with NFPA 70.
3. Wire, Conduit, and Enclosures:
 - a. Minimum Conduit Size: [3/4 inch] <Insert dimension>.
 - b. Materials: Metal, with a corrosion-resistant finish Aluminum or stainless steel Stainless steel.
 - c. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware[**constructed of stainless steel**].
 - d. Conduit: Locate conduit inside the air-handling unit casing. Conduit installed on exterior of air-handling unit casing is unacceptable.
 - e. Wire:
 - 1) Copper, rated for 600 V, solid wire for size [**No. 10 AWG**] <Insert wire size> and smaller and stranded wire for larger sizes.
 - 2) Minimum Wire Size: [**No. 12 AWG**] <Insert wire size>.
 - 3) Each circuit shall have a ground wire.
 - 4) Install wire in conduit.
 - f. Boxes, Conduit Outlet Bodies, and Enclosures:
 - 1) Located in Airstream: NEMA 250, Type 4 Type 4X Type 12 Insert Type.
 - 2) Located in Service Corridor: NEMA 250, Type 1 Type 4 Type 12 Insert Type.
 - 3) Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 3R Type 4 Type 4X Insert Type.
 - g. Seals: Seal pathways to prevent air leakage between air-handling unit exterior and interior, and between internal component sections.

- h. UV-C Lamp System Applications: Wire all UV-C lamp systems located in the same air tunnel to a single circuit.
 - i. Service Lighting Applications:
 - 1) Provide quantity of 20-A branch circuits required to power service light fixtures.
 - 2) For air-handling units consisting of multiple stacked tiers, provide separate circuits for top and bottom tiers of air-handling units.
 - 3) Factory install a main disconnect switch field power junction box for interfacing air-handling power for service lighting with single-point field power wiring connection.
 - j. Receptacle Applications:
 - 1) For air-handling units consisting of multiple stacked tiers, provide separate circuits for top and bottom tiers of air-handling units.
 - 2) Factory wire receptacles to a main disconnect switch field power junction box for interfacing air-handling power for receptacles with a single-point field power wiring connection.
- B. Main Disconnect Switches: Factory-install main disconnect switch mounted on air-handling unit casing exterior for interface of factory power wiring with field power wiring.
- 1. Specification Grade: "Heavy Duty Type"; "quick-make," "quick-break" construction.
 - 2. Three pole, fused or nonfused.
 - 3. 600 V rated.
 - 4. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 42,000 65,000 Insert value A.
 - 5. Enclosure:
 - a. Located in Service Corridor: NEMA 250, Type 1 Type 4 Type 12 Insert Type.
 - b. Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 3R Type 4 Type 4X Insert Type.
 - 6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
 - 7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
 - 8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
 - 9. Include a solid neutral as required by authorities having jurisdiction.
 - 10. Disconnect switch shall have a ground lug for ground wire termination.
 - 11. Operating handle shall be lockable in open position.
 - 12. Horsepower rated.
 - 13. Feed through or double lugged.
- C. Field Power Junction Box: Factory-install junction box with internal wire terminal block mounted on air-handling unit casing exterior for interface of factory power wiring with field power wiring.
- D. Exterior Service Light Fixtures:
- 1. LED Luminaires for Outdoors:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>**.
 - b. Finish: Selected by Architect from available finishes offered by manufacturer.
 - c. Mounting: Wall.
 - d. Intended for direct exposure in outdoor locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - e. Light Color: 4000 5000 K.
 - f. Light Output: 3000 6000 8000 lumens.
 - g. Additional Protection: Vandal guard wire guard.
 - h. On/Off Operation: Local toggle switch Photo cell with local override toggle switch.

2. Vaportight Fixtures:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>**.
 - b. Finish: Selected by Architect from available finishes offered by manufacturer.
 - c. Mounting: Wall.
 - d. Intended for direct exposure in outdoor locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - e. Cast-aluminum housing and guard with heat-resistant, tempered, clear glass globe.
 - f. Incandescent Lamps: 150 200 300 W.
 - g. LED A21 Series Lamps:
 - 1) Light Color: 3000 5000 K.
 - 2) Light Output: [1700] **<Insert value>** lumens.
 3. Application:
 - a. Provide service light fixtures where indicated on Drawings.
- E. Interior Service Light Fixtures:
1. Fluorescent Luminaires:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>**.
 - b. Suitable for wet locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - c. High-impact, UV-stabilized, fiberglass-reinforced polyester housing; high-impact acrylic lens.
 - d. Two, cool white, T 5 5HO 8 8HO lamps; and an electronic ballast.
 2. LED Luminaires:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>**.
 - b. Suitable for wet locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - c. High-impact, UV-stabilized fiberglass housing and acrylic lens.
 - d. Light Color: 3500 4000 5000 K.
 - e. Light Output: 2000 3000 4000 lumens.
 - f. Driver: 1 percent dimming.
 3. Vaportight Fixtures:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide **<Insert manufacturer's name; product name or designation>**.
 - b. Suitable for wet locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
 - c. Cast-aluminum housing and guard with heat-resistant, tempered, clear glass globe.
 - d. Incandescent Lamps: 150 200 300 W.
 - e. LED A21 Series Lamps:
 - 1) Light Color: 3000 5000 K.
 - 2) Light Output: [1700] **<Insert value>** lumens.
 4. Application:
 - a. Provide service light fixtures where indicated on Drawings.
- F. Toggle Switches for Service Light Fixtures:
1. Single-Pole Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.
 2. Two-Pole Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.
 3. Three-Way Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.
 4. Four-Way Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

5. Lighted Single-Pole Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - a. Description: Handle illuminated when switch is on.
6. Toggle Switch Box and Cover: Mount toggle switch in a metal cast-aluminum outlet box with cast-aluminum stainless steel cover. Weatherproof where exposed to outdoors.
7. Application:
 - a. Factory install switching configuration (single, three way, or four way) required to operate a single service light fixture or group of service light fixtures from any access door that opens to respective service light fixtures.
 - b. Factory install service light switches at locations indicated on Drawings.
8. Switches with Lighted Handles Applications: Lighted handle feature may be omitted where on/off status of internal lights can be viewed through an access door window.

G. Receptacles:

1. Isolated-Ground Duplex Receptacles, 125 V, 20 A:
 - a. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
 - b. Configuration: NEMA WD 6, Configuration 5-20R.
 - c. Standards: Comply with UL 498 and FS W-C-596.
2. Duplex GFCI Receptacles, 125 V, 20 A:
 - a. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
 - b. Configuration: NEMA WD 6, Configuration 5-20R.
 - c. Type: Non-feed through.
 - d. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
3. Receptacle Box and Cover: Mount receptacle in a metal cast-aluminum outlet box with cast-aluminum stainless steel cover. Weatherproof where exposed to outdoors.
4. Applications: Factory install a receptacle in a convenient and field-accessible location on air-handling unit exterior of casing at locations indicated on Drawings near access doors accessing fans near access doors accessing electric heaters and fans near access doors accessing energy wheels and fans near access doors accessing electric heaters, energy wheels and fans Insert locations.

H. Power Supply to Fan Motors:

1. As indicated on Drawings.

I. Disconnect Switches:

1. Specification Grade: "Heavy Duty Type"; "quick-make," "quick-break" construction.
2. Three pole, fused nonfused.
3. 600 V rated.
4. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 42,000 65,000 Insert value A.
5. Enclosure:
 - a. Located in Service Corridor: NEMA 250, Type 1 Type 4 Type 12 Insert Type.
 - b. Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 3R Type 4 Type 4X Insert Type.
6. Operating handle shall be of box-mounted type that directly drives switch mechanism.

7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
 8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
 9. Include a solid neutral as required by authorities having jurisdiction.
 10. Disconnect switch shall have a ground lug for ground wire termination.
 11. Operating handle shall be lockable in open position.
 12. Horsepower rated.
 13. Feed through or double lugged.
- J. Motor Field Power Junction Box:
1. Provide junction box with internal wire terminal block mounted on unit exterior for interface with field power wiring.
 - a. Provide for each motor not installed with a factory disconnect or controller with integral disconnect.
 2. Factory install internal wiring and conduit to motor.
- K. Motor Controllers:
1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.
 2. Configured for control of single- or multispeed motors as indicated.
 3. Enclosure: Hinged full-front access door with lock and key.
 - a. Located in Service Corridor: NEMA 250, Type 1 Type 4 Type 12 Insert Type.
 - b. Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 3R Type 4 Type 4X Insert Type.
 4. Externally Operated Disconnect: Door-Interlocked, with lockable handle.
 5. Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 42,000 65,000 100,000 Insert value A.
 6. Hand-Off-Auto Switch: Mounted on face of enclosure.
 7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
 8. Control Relays: Time-delay relays.
 9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
 10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
 11. Number-of-Starts Counter: Numerical readout on face of enclosure.
- L. Variable-Frequency Controllers:
1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.
 2. Enclosure: Unit mounted, with hinged full-front access door with lock and key.
 - a. Located in Service Corridor: NEMA 250, Type 1 Type 4 Type 12 Insert Type.
 - b. Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 3R Type 4 Type 4X Insert Type.
 3. Externally Operated Disconnect: Door-Interlocked, with lockable handle.
 4. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 42,000 65,000 100,000 Insert value A.
 5. Technology: Pulse-width-modulation (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
 6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
 7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
 8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.

9. Operating Requirements:
 - a. Input AC Voltage Tolerance: [10] <Insert number> percent.
 - b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
 - c. Capable of driving full motor load, without derating.
 - d. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - e. Minimum Displacement Primary-Side Power Factor: 95 percent.
 - f. Overload Capability: 1.05 times the full-load current for 7 seconds.
 - g. Starting Torque: As required by fan and motor drive assembly.
 - h. Speed Regulation: 1 percent.
 - i. Speed Range: 10:1 speed range.
 - j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
 - k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.
10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or need for replacement:
 - a. Surge suppression.
 - b. Loss of input signal protection.
 - c. Critical frequency rejection.
 - d. Overtemperature.
 - e. Short circuit at controller output.
 - f. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
 - g. Open circuit at controller output.
 - h. Input undervoltage.
 - i. Input overvoltage.
 - j. Loss of input phase.
 - k. Reverse phase.
 - l. AC line switching transients.
 - m. Instantaneous overload, line to line or line to ground.
 - n. Sustained overload exceeding 100 percent of controller rated current.
 - o. Starting a rotating motor.
 - p. <Insert features>.
12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
13. Automatic Reset and Restart:
 - a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
 - b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.
14. Visual Indication: On face of controller; indicating the following conditions:
 - a. Power on.
 - b. Run.
 - c. Overcurrent and overvoltage.
 - d. Motor speed (percentage).
 - e. Various faults with alarm status.
 - f. Input kilovolt amperes.
 - g. Power factor.
 - h. Input kilowatts and kilowatt-hours.
 - i. Three-phase input and output voltage.
 - j. Three-phase input and output current.
 - k. Output frequency.
 - l. Elapsed operating time (hours).
 - m. Diagnostic and service parameters.

- n. **<Insert conditions>**.
- 15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
- 16. Hardwired Control Signal Interface: A minimum of two Insert number analog inputs (0 to 10 V or 0/4 to 20 mA) and four Insert number programmable digital inputs.
- 17. Remote Communication Interface: ASHRAE 135 BACnet MS/TP ASHRAE 135 BACnet IP Insert requirements.
- 18. Line Conditioning:
 - a. Input line conditioning.
 - b. Output filtering.
 - c. EMI/RFI filtering.
- 19. Bypass Controller:
 - a. Bypass Controller/Variable-Frequency Controller Selector Switch: Include manual selector switch on face of enclosure for local operator control of preferred controller.
 - b. Bypass Mode: Manual operation only Field-selectable automatic or manual.
 - 1) In automatic mode, include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
 - c. Type: Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
 - d. Arrangement: Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
 - e. Enclosure: Install bypass controller in same enclosure as variable-frequency controller.
 - f. Remote Monitoring: Include control relay for remote indication of bypass controller operation.

2.22 FACTORY-ASSEMBLED CONTROLS

- A. General:
 - 1. Air-handling unit manufacturer shall furnish and factory install control instruments, control power circuit, control transformers, power supplies, wiring, tubing, raceways, and control panels.
 - 2. Provide for a single-point field connection to [120] [277]-V electrical power for all factory-installed controls. Terminate power connection with a toggle switch mounted in control panel.
 - 3. Control panel shall serve as field tie-in point for all electric damper actuators, and control instruments located within air-handling unit. Controls for control dampers, control valves and instruments installed in ductwork and piping are not included as part of air-handling unit factory-installed controls.
 - 4. Control instruments shall be installed in accordance with manufacturer's written instructions.
 - 5. Control panel shall house flow, moisture, pressure and temperature transmitters, transformers, dc voltage power supplies, and wiring terminal strip.
 - 6. Carbon dioxide transmitters shall be mounted on air-handling unit casing exterior with sensor port exposed to the airstream.
 - 7. Factory install the following control instruments:
 - a. Flow station and flow transmitter for each fan.
 - b. Pressure sensors (inlet and discharge) and one combination pressure differential transmitter, switch, and controller for each filter bank installed in the air-handling unit.
 - c. Pressure sensor and combination pressure differential transmitter, switch, and controller at the inlet of each fan.
 - d. Pressure sensor and combination pressure differential transmitter, switch, and controller at the discharge of each fan.
 - e. Carbon dioxide sensor/transmitters at locations indicated on Drawings.
 - f. Moisture and temperature sensors and transmitters at locations indicated on Drawings.
 - g. Temperature switches at locations indicated on Drawings.
 - h. Control instruments indicated on Drawings.
 - i. **<Insert requirements>**.

B. Wire and Cable:

1. Single Conductor Control Wiring above 24 V:
 - a. Wire size shall be at least No. 16 AWG.
 - b. Conductor shall be 7/24 soft annealed copper stranding with a 2- to 2-1/2-inch lay.
 - c. Conductor insulation shall be 600 V, Type THWN or Type THHN, 90 deg C in accordance with UL 83.
 - d. Conductor colors shall be black (hot), white (neutral), and green (ground).
2. Single Twisted Shielded Instrumentation Cable above 24 V:
 - a. Wire size shall be minimum No. 18 AWG.
 - b. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2-1/2-inch lay.
 - c. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
 - d. Shielding shall be 100 percent 0.35/0.5-mil aluminum/mylar tape, helically applied with 25 percent overlap, and aluminum side in with a No. 18 AWG-7/26 tinned copper drain wire.
 - e. Outer jacket insulation shall have a 600-V, 90 deg C rating and shall be Type TC cable.
 - f. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red, and white.
3. Single Twisted Shielded Instrumentation Cable 24 V and Lower:
 - a. Wire size shall be minimum No. 18 AWG.
 - b. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2-1/2-inch lay.
 - c. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
 - d. Shielding shall be 100 percent 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with a No. 20-22 AWG tinned copper drain wire.
 - e. Outer jacket insulation shall have a 300-V, 105 deg C rating and shall be Type PLTC cable.
 - f. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red, and white.
4. Wire and Cable Installation:
 - a. Comply with manufacturer's written instructions and NFPA 70.
 - b. Grounding shall be in accordance with IEEE C2. Ground wire shall be copper. Demonstrate ground resistance.
 - c. Wiring and cables shall be installed in conduit. Exposed wire and cable are unacceptable.
 - d. Wire and cables may be grouped in a common raceway, except do not group wires and cables from different voltages.
 - e. Install control wiring in a separate conduit from power wiring.
 - f. Wiring shall be continuous from terminal to terminal without splices.
 - g. Do not install low-voltage wire and cable closer than [12 inches] <Insert distance> from line voltage electrical power wire and cables. Provide an installation free of EMI.
 - h. Use insulated spade lugs for wiring connection to screw terminals.
 - i. Use shielded cable to transmitters.
 - j. Terminate wiring and cables within a control panel, within instrument housing, or in a junction box. Clamp the cable over the jacket, in the junction box. Individual conductors in the stripped section of cable shall be slack between clamping point and terminal block.
 - k. Terminate wire and cable in control panel with terminal blocks.
 - l. Identify each wire and cable on each end and at each terminal with a number coded identification tag. Each wire and cable conductor shall have a unique tag.
 - m. Perform continuity and meager testing on wiring and cable.

C. Raceways:

1. Conduit:
 - a. Install wiring and cable in conduit.

- b. Minimum Conduit Size: 1/2 inch 3/4 inch Insert dimension.
 - c. Materials: Metal, corrosion resistant and constructed of stainless steel.
 - d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware[**constructed of stainless steel**].
 - e. Terminations to Actuators and Instruments: Flexible conduit, NRTL listed, not to exceed 24 inches long.
 2. Boxes, Conduit Outlet Boxes, and Enclosures:
 - a. Located in Airstream: NEMA 250, Type 4X Type 12 Insert Type.
 - b. Located in Service Corridor: NEMA 250, Type 1 Type 4 Type 12 Insert Type.
 - c. Located on Exterior of Air-handling Unit Casing: NEMA 250, Type 4 Type 4X Insert Type.
 3. Seals: Seal pathways to prevent air leakage between air-handling unit exterior and interior, and between internal component sections.
 4. Conduit Installation:
 - a. Conduit shall be continuous and secured in a manner that is electrically continuous throughout.
 - b. Secure threaded conduit entering a cabinet, box or enclosure with a locknut on outside and on inside, such that conduit system is electrically continuous throughout.
 - 1) Install a metal bushing with insulated throat on inside.
 - 2) Locknuts designed to bite into metal, or on inside of enclosure and shall have a grounding wedge lug under locknut.
 - c. Conduit box connectors for conduit entering enclosures shall be insulated throat type.
 - d. Connect conduit with watertight sealing locknuts that are suitable for wet applications.
 - e. Offset conduits where they enter surface-mounted equipment and panels.
 - f. Neatly loop and lace wiring installed in panels and other enclosures.
 - g. Seal conduit runs to prevent the circulation of air by installing seal fittings.
 - h. Install conduit inside of air-handling unit casing. Wiring and conduit running on exterior of air-handling unit casing is unacceptable.
- D. Tubing and Fittings:
 1. Products in this paragraph are intended for use with the following:
 - a. Main air and signal air to pneumatically controlled instruments, actuators, and other control devices and accessories.
 - b. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers, and accessories.
 2. Copper Tubing:
 - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties in accordance with ASTM B75/B75M.
 - b. Performance, dimensions, weight and tolerance in accordance with ASTM B280.
 - c. Diameter, as required by application, not less than nominal 0.25 inch.
 - d. Wall thickness, as required by application, but not less than 0.030 inch.
 3. Copper Tubing Fittings: Brass, compression type.
 4. Polyethylene Tubing:
 - a. Fire-resistant black virgin polyethylene in accordance with ASTM D1248, Type 1, Class C and Grade 5.
 - b. Tubing shall comply with stress crack test in accordance with ASTM D1693.
 - c. Diameter, as required by application, of not less than nominal 0.25 inch.
 5. Polyethylene Tubing Fittings: Brass, compression type.
 6. Stainless Steel Tubing:
 - a. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, free from scale.
 - b. Chemical and physical properties in accordance with ASTM A269/A269M.

- c. Diameter, as required by application, of not less than nominal 0.25 inch.
 - d. Wall thickness, as required by application, but not less than 0.035 inch.
 - e. Furnish stainless steel tubing in 20-foot straight random lengths.
7. Stainless Steel Tubing Connectors and Fittings:
- a. Connectors and fittings shall be stainless steel, with stainless steel collets, flareless type.
 - b. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on other end.
8. Tubing Installation:
- a. Use copper stainless steel tubing except use fire-resistant polyethylene for tubing located in control panels.
 - b. Run tubing parallel to, and at right angles to, casing.
 - c. Route multiple runs of tubing in neat parallel lines.
 - d. Support tubing as follows:
 - 1) Support metal tubing with hangers, clips, and tube trays.
 - 2) Do not use tapes for mounting tubing.
 - 3) Place a support within 1 foot of each change in direction and each branch take off.
 - 4) Spacing between supports shall not exceed [60 inches] <Insert distance>.
 - e. Tubing shall not interfere with access to dampers and equipment or obstruct passageways of any kind.
 - f. Provide vibration loops in tubing when connecting to equipment that might vibrate.
 - g. Where joining or mating dissimilar metals where galvanic action could occur, provide dielectric isolation.
 - h. Make tubing bends with a bending tool. Hard bends, or wrinkled or flattened bends are unacceptable.
 - i. Install tubing fitting make-up in accordance with manufacturer's written instructions.
 - j. Do not make tubing connections to a fitting before completing make-up connection.
 - k. Properly align tubing with fitting. Springing tube into position can result in excessive stress on both tubing and fitting with possible resulting leaks.
 - l. Do not install fittings close to a bend. Length of straight tubing, not deformed by bending is required for a proper connection.
 - m. Check tubing for correct diameter and wall thickness. Tube ends shall be cut square and deburred. Exercise care during cutting to keep tubing round.
 - n. Wrap threads of fittings with a single wrap of PTFE tape.
 - o. Install tubing with extreme care to keep foreign matter out. Keep open ends of tubing plugged to keep out dust, dirt, and moisture.
 - p. Mark each tube on each end with a number-coded identification. Each tube shall have a unique number.
 - q. Test tubing as follows:
 - 1) Test for leaks and obstructions. Disconnect each tubing run before test is run, and blow out trash, condensate, and other foreign material with compressed air.
 - 2) After foreign matter is expelled and the line is free from obstructions, plug the far end of tubing run.
 - 3) Connect a pressure source to the near end with a needle valve between air supply and tubing run. Only commercially pure dry compressed air or nitrogen as distributed in gas cylinders is acceptable for this test.
- E. Control Panels:
- 1. Design control panels for grouping and protecting various electric, and/or electronic components.
 - 2. NRTL listed in accordance with UL 50 or UL 50E.
 - 3. Enclosure:
 - a. Located in Service Corridor: NEMA 250, Type 1 Type 4 Type 12 Insert Type.
 - b. On Exterior of Air-Handling Unit Casing: NEMA 250, Type 4 Type 4X Insert Type.
 - 4. Construct enclosure of steel, not less than the following:

- a. Enclosure Size Less Than 24 inches: 0.053 inch 0.067 inch thick.
 - b. Enclosure size 24 inches and Larger: 0.067 inch 0.093 inch thick.
5. Support front panel using a non-removable piano hinge that runs entire height of cabinet.
 6. Each panel shall not exceed height of air-handling unit casing and 72 inches high.
 7. Secure front panel with a key locking mechanism. Common key the locks, and provide one pair of keys per panel.
 8. Front panel with a window of size so all instrument displays are visible with door closed.
 9. Mount panels on exterior wall of air-handling unit casing on primary access side of unit.
 10. Paint control panel exterior with enamel at least 5 mils thick. Color of panel exterior and interior shall be white.
 11. Include panel field power supply with a toggle-type switch located at entrance inside panel to disconnect power.
 12. Include panel with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
 13. Size control panel to provide at least 25 percent spare area on subpanel.
 14. Arrange control panel so similar type equipment is grouped together, and a barrier is installed between electrical and electronic equipment.
 15. Interior ambient temperature shall not rise above manufacturer's recommended maximum operating temperature for products installed within the panels. Provide filtered louvers and circulating fans, when necessary, to meet criteria.
 16. Panel shall serve as a central tie-in point for control devices such as remote sensors, transmitters, power supplies, and transformers.
 - a. Factory install internal wiring in compliance with specified standards.
 - b. Terminate wiring using an electric terminal strip with heavy-duty terminal blocks.
 - c. Include spare terminals, equal to not less than **[10] [20] <Insert number>** percent of used terminals.
 - d. Include spade lugs for stranded wire.
 - e. Install a maximum of two wires on each side of a terminal.
 - f. Label each end of cable, wire, and tubing within panel following an approved identification system.
 17. Polyethylene tubing may be used within panel enclosure in place of copper.
 18. Supply each control panel with a complete set of as-built schematics, tubing, and wiring diagrams that are bound in a three-ring protective binder and located within panel.
 19. Mount instruments and other products within control panel on an internal panel(s) and provide with nameplates. Provide engraved, laminated phenolic nameplates (black letters on a white background). Nameplates shall have at least 1/4-inch- high lettering.
 20. Route tubing, cable and wiring located inside control panel within a raceway that has a continuous removable cover.

F. Pitot Tube Airflow Stations:

1. Fan Inlet Airflow Sensor (Piezometer Ring):
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Greenheck Fan Corporation.
 - 2) Twin City Fan & Blower.
 - 3) ebm-papst Inc.
 - 4) Insert manufacturer's name.
 - b. Source Limitations: Obtain sensors from single source from single manufacturer.
 - c. Provide fans with airflow measurement integral to fan inlet cones for continuously measurement of air volume flow rate.

- d. Fan inlet airflow sensor shall contain multiple pressure sensor points strategically placed along the circumference of the inlet cone and internally connected to an averaging ring manifold located behind the inlet cone.
- e. Sensor points shall neither protrude beyond the surface of the inlet cone nor be adversely affected by particle contamination present in the airstream.
- f. Sensor shall produce steady, non-pulsating signals to achieve accuracy within 5 percent of actual airflow.
- g. Sensor shall be non-intrusive and not impact fan performance.
- h. Product shall be a standard offering of fan manufacturer and include published literature with supporting test data to validate sensor performance.

G. Thermal Airflow Measurement Stations:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Air Monitor; an ONICON Brand.
 - b. Ebtron, Inc.
 - c. Insert manufacturer's name.
2. Source Limitations: Obtain stations from single source from single manufacturer.
3. Description: Airflow station shall consist of one or more sensor probes and a remotely mounted microprocessor-based transmitter.
4. Performance:
 - a. Capable of independently processing up to **[16]** **<Insert number>** independently wired sensor assemblies.
 - b. Airflow rate of each sensor assembly shall be equally weighted and averaged by transmitter prior to output.
 - c. Temperature of each sensor assembly shall be velocity weighted and averaged by transmitter prior to output unless temperature sensor has an accuracy of 0.1 deg F.
 - d. Listed and labeled by an NRTL as successfully tested as an assembly in accordance with UL 873 or UL 60730.
 - e. Components shall be interconnected by exposed NRTL-listed plenum-rated cable or non-plenum-rated cable placed in conduit.
 - f. Each flow station shall be factory calibrated at a minimum of six 16 Insert number airflow rates and two three Insert number temperatures to standards that are traceable to NIST.
 - g. Individual Sensor Airflow Accuracy: Within 2 3 Insert number percent of reading over the entire operating airflow range.
 - h. Thermal Airflow Station Assembly Airflow Accuracy: Within 2 3 5 Insert number percent of reading over the entire operating airflow range.
 - 1) Devices whose accuracy is combined accuracy of transmitter and sensor probes must demonstrate that total accuracy meets performance requirements throughout the measurement range.
 - i. Temperature Accuracy: Within 0.2 deg F over entire operating range of minus 20 to plus 140 deg F.
 - j. Sensor Ambient Operating Temperature Range: Minus 20 to plus 160 deg F.
 - k. Transmitter Ambient Operating Temperature Range: Minus 20 to plus 120 deg F.
 - l. Sensor and Transmitter Ambient Operating Humidity Range: Zero to 99 percent, noncondensing.
 - m. Instrument shall compensate for changes in air temperature and density throughout calibrated velocity range for seasonal extremes at Project location.
 - n. Pressure Drop: 0.05 inch wg at 2000 fpm across a 24-by-24-inch area.
 - o. Instruments mounted in throat or face of fan inlet cone shall not negatively influence fan performance by reducing flow more than **[1]** **[2]** **<Insert number>** percent of Project design flow or negatively impact fan-generated sound. Losses in performance shall be documented with submittal data, and adjustments to compensate for performance impact shall be made to fan to deliver Project design airflow indicated.

5. Sensor Assemblies:
 - a. Each sensor probe shall contain two individually wired, hermetically sealed **[bead-in-glass]** thermistors.
 - b. Mount thermistors in sensor using a marine-grade, waterproof material.
 - c. Thermistor leads shall be protected and not exposed to environment.
 - d. Each sensor assembly shall independently determine airflow rate and temperature at each measurement point.
 - e. Each sensor probe shall have an integral cable for connection to remotely mounted transmitter.
 - f. Sensor Probe Material: Gold anodized, extruded Alloy 6063 aluminum tube or Type 304 stainless steel.
 - g. Probe Assembly Mounting Brackets Material: Type 304 stainless steel.
6. Transmitter:
 - a. Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
 - b. Capable of field configuration and diagnostics using an onboard push-button interface and digital display.
 - 1) Include an integral power switch to operate on 24-V ac (isolation not required) and include the following:
 - a) Integral protection from transients and power surges.
 - b) Circuitry to ensure reset after power disruption, transients, and brownouts.
 - c) Integral transformer to convert field power source to operating voltage required by instrument.
 - c. Remote Signal Interface:
 - 1) Linear Analog Signals for Airflow and Temperature: Fuse protected and isolated, **[field selectable,] [0 to 10 V dc] [or] [4 to 20 mA]**.

H. Flow Transmitters for Pitot Tube Sensors:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Air Monitor; an ONICON Brand.
 - b. Insert manufacturer's name.
2. Source Limitations: Obtain sensors from single source from single manufacturer.
3. Receives total and static pressure signals from a flow element, amplify, extract the square root, and scale the signal to produce a 4- to 20-mA dc output signal linear to airflow.
4. Housed in NEMA 250, Type 1 enclosure.
5. Assembly constructed so that shock, vibration, and pressures surges of up to 1 psig will neither harm transmitter nor affect its accuracy.
6. Provide transmitter with an automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. Automatic zeroing circuit shall re-zero transmitter to within 0.1 percent of true zero.
7. Performance:
 - a. Range: At least 20 percent below minimum airflow and 20 percent greater than design airflow.
 - b. Calibrated Span: Field adjustable, minus 40 percent of the range.
 - c. Accuracy: Within 0.10 percent of natural span.
 - d. Repeatability: Within 0.15 percent of calibrated span.
 - e. Linearity: Within 0.2 percent of calibrated span.
 - f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.

8. Equip transmitter with an integral digital LED or LCD for continuous indication of airflow.
 9. Install in control panel.
- I. Humidity Sensors and Transmitters with Digital Display:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Vaisala.
 - b. Insert manufacturer's name.
 2. Source Limitations: Obtain sensors and transmitters from single source from single manufacturer.
 3. Performance:
 - a. Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 2.5 percent from 90 to 100 percent relative humidity when operating between 60 to 77 deg F.
 - b. Relative Humidity Range: Zero to 100 percent.
 - c. Factory calibrated and NIST traceable with certificate included.
 4. Construction:
 - a. Provide housing with remote sensor probe for ducted applications.
 - 1) Duct Sensor Body: 300 series stainless steel or chrome-plated aluminum, at least 2 inches long for duct-mounted applications.
 - 2) Provide sensor with cable for field installation in conduit.
 - 3) For duct-mounted applications, thread the sensor assembly for connection to a threaded mounting flange.
 - b. Provide general-purpose humidity sensor unless application requires special requirements. Provide sensor with sintered stainless steel filter.
 - c. Housing shall be ABS/PC plastic or powder-coated aluminum.
 - d. Housing Classification: NEMA 250, Type 4 or Type 4X.
 - e. Provide housing with wall-mounting plate.
 5. Output Signal: Two-wire, 4- to 20-mA output signal with a drive capacity of at least 500 ohms at 24 V dc.
 6. Provide unit with a digital display of relative humidity in percent.
- J. Air Pressure Sensors:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Dwyer Instruments, Inc.
 - b. Insert manufacturer's name.
 2. Source Limitations: Obtain sensors from single source from single manufacturer.
 3. Insertion length shall be at 4 inches 6 inches 8 inches 12 inches.
 4. Sensor with four radial holes of 0.04-inch diameter.
 5. Brass stainless steel construction.
 6. Sensor with threaded end support, sealing washers, and nuts.
 7. Connection: NPS 1/4 compression fitting.
- K. Air-Pressure Differential Indicating Transmitter, Switch, and Controller:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following]** **[provide products by one of the following]** **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Dwyer Instruments, Inc.

- b. Insert manufacturer's name.
2. Source Limitations: Obtain from single source from single manufacturer.
3. Description:
 - a. Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.
 - b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
 - c. Select instrument range based on application. Range shall be approximately 2 times set point.
4. Performance:
 - a. Accuracy Including Hysteresis and Repeatability:
 - 1) Within 1 percent for ranges less than 5 inches wg.
 - 2) Within 0.5 percent at 77 deg F for other ranges.
 - b. Stability: Within 1 percent per year.
 - c. Response Time: 250 ms.
 - d. Overpressure: 5 psig for instrument ranges less than 50 inch wg and 9 psig for 100-inch wg range.
 - e. Temperature Limits: 32 to 140 deg F.
 - f. Thermal Effects: 0.020 percent per deg F.
 - g. Warm-up Period: One hour.
5. Controller Programming through Menu Keys to Access Five Menus:
 - a. Security level.
 - b. Pressure, velocity, or flow application.
 - c. Engineering units.
 - d. K-factor for use with flow application.
 - e. Set-point control only; set-point and alarm operation; and alarm operation as high, low, or high/low with manual or automatic reset and delay.
 - f. View high and low readings.
 - g. Digital dampening for smoothing erratic applications.
 - h. Scaling of analog output to fit range and field calibration.
6. Display:
 - a. Digital, four-digit display with backlight, with 0.4-inch- high, alphanumeric characters.
 - b. Four indicators; two for set point and two for alarm status.
7. Operator Interface:
 - a. Set-point adjustment through keypad on face of instrument.
 - b. Zero and span adjustments accessible through menu.
 - c. Programming through keypad.
8. Analog Output Signal:
 - a. Two-wire, 4- to 20-mA dc current source.
 - b. Signal capable of operating into a 900-ohm load.
9. Digital Output Signal:
 - a. Two SPDT relays.
 - b. Each rated for 1 A at 30 V ac or dc.
10. Construction:
 - a. Die cast-aluminum casing and bezel.
 - b. Threaded, NPS 1/8 connections on side and back.
 - c. Vertical plane mounting.
 - d. NEMA 250, Type 1.
 - e. Nominal 4-inch- diameter face.

f. Mounting Bracket: Appropriate for installation.

L. Carbon Dioxide Sensors/Transmitters:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Vaisala.
 - b. Insert manufacturer's name.
2. Source Limitations: Obtain sensors/transmitters from single source from single manufacturer.
3. Description:
 - a. NDIR technology or equivalent technology providing long-term stability and reliability.
 - b. Two-wire, 4- to 20-mA output signal; linearized to carbon dioxide concentration in ppm.
4. Construction:
 - a. House electronics in an ABS plastic enclosure. Provide equivalent of NEMA 250, Type 4.
 - b. Equip with digital display for continuous indication of carbon dioxide concentration.
5. Performance:
 - a. Measurement Range: 0 to 2000 ppm.
 - b. Accuracy: Within 2 percent of reading, plus or minus 30 ppm.
 - c. Repeatability: Within 1 percent of full scale.
 - d. Temperature Dependence: Within 0.05 percent of full scale over an operating range of 25 to 110 deg F.
 - e. Long-Term Stability: Within 5 percent of full scale after more than five years.
 - f. Response Time: Within 60 seconds.
 - g. Warm-up Time: Within five minutes.
6. Provide calibration kit. Turn over to Owner at start of warranty period.

M. Air Temperature Sensors:

1. Platinum Resistance Temperature Detector (RTD): Common Requirements:
 - a. 100 or 1000 ohms at 0 deg C and a temperature coefficient of 0.00385 ohms/ohm/deg C.
 - b. Two-wire Teflon insulated 22-gauge stranded copper leads.
 - c. Performance Characteristics:
 - 1) Range: Minus 50 to plus 275 deg F.
 - 2) Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
 - 3) Repeatability: Within 0.5 deg F.
 - 4) Self-Heating: Negligible.
 - d. Transmitter Requirements:
 - 1) Transmitter required for each 100-ohm RTD.
 - 2) Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
2. Platinum RTD, Averaging Sensor:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Minco.
 - 2) Insert manufacturer's name.
 - b. Source Limitations: Obtain sensors from single source from single manufacturer.
 - c. **[100] [or] [1000] ohms.**

- d. Temperature Range: Minus 50 to plus 275 deg F.
- e. Multiple sensors to provide average temperature across entire length of sensor.
- f. Rigid probe of aluminum, brass, copper or stainless steel sheath.
- g. Flexible probe of aluminum, brass, copper or stainless steel sheath and formable to a 4-inch radius.
- h. Length: As required by application to cover entire cross section of air tunnel.
- i. Enclosure: Junction box with removable cover; NEMA 250, Type 4.
- j. Gasket for attachment to duct or equipment to seal penetration airtight.
- k. Conduit Connection: 1/2-inch trade size.

N. Air Temperature Switches:

- 1. Thermostat and Switch for Low Temperature Control:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Honeywell Building Solutions; Honeywell International, Inc.
 - 2) Siemens Industry, Inc., Building Technologies Division.
 - 3) Insert manufacturer's name.
 - b. Source Limitations: Obtain switches from single source from single manufacturer.
 - c. General:
 - 1) Two-position control.
 - 2) Field-adjustable set point.
 - 3) Manual reset.
 - 4) NRTL listed.
 - d. Performance:
 - 1) Operating Temperature Range: 15 to 55 deg F.
 - 2) Temperature Differential: 5 deg F, non-adjustable and additive.
 - 3) Enclosure Ambient Temperature: Minus 20 to plus 140 deg F.
 - 4) Sensing Element Maximum Temperature: 250 deg F.
 - 5) Voltage: 120 V ac.
 - 6) Current: 16 full-load A.
 - 7) Switch Type: Two SPDT snap switches operate on coldest 12-inch section along element length.
 - e. Construction:
 - 1) Vapor-Filled Sensing Element: Nominal 20 feet long.
 - 2) Dual Temperature Scale: Fahrenheit and Celsius visible on face.
 - 3) Set-Point Adjustment: Screw.
 - 4) Enclosure: Painted metal, NEMA 250, Type 1.
 - 5) Electrical Connections: Screw terminals.
 - 6) Conduit Connection: 1/2-inch trade size.

O. Air Temperature RTD Transmitters:

- 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Minco.
 - b. Insert manufacturer's name.
- 2. Source Limitations: Obtain transmitters from single source from single manufacturer.
- 3. House electronics in NEMA 250, Type 1 enclosure. Mount transmitter in control panel.
- 4. Conduit Connection: 1/2-inch trade size.
- 5. Functional Characteristics:

- a. Input:
 - 1) 100-ohm platinum RTD temperature coefficient of 0.00385 ohms/ohms/deg C; two-wire sensors.
 - 2) 1000-ohm platinum RTD temperature coefficient of 0.00385 ohms/ohms/deg C; two-wire sensors.
 - b. Span (Adjustable):
 - 1) Exhaust Air: 50 to 100 deg F.
 - 2) Mixed Air: Minus 40 to plus 140 deg F.
 - 3) Outdoor: Minus 40 to plus 140 deg F.
 - 4) Supply Air, Cooling, and Heating: 40 to 120 deg F.
 - 5) Return Air: 50 to 100 deg F.
 - c. Output: 4- to 20-mA dc linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24 V dc.
 - d. Zero and span field adjustments plus or minus 5 percent of span. Minimum span 50 deg F.
 - e. Match sensor with temperature transmitter and factory calibrate together.
6. Performance Characteristics:
- a. Calibration Accuracy: Within 0.1 percent of span.
 - b. Stability: Within 0.2 percent of span for at least six months.
 - c. Combined Accuracy: Within 0.5 percent.
7. Provide each transmitter with a digital display.
- P. Liquid Flow Meters:
1. General: Extended range of 10 to 20 percent above Project design flow and 10 to 20 percent below Project minimum flow to signal abnormal flow conditions.
 2. In-Line Body Electromagnetic Flow Meter:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) ONICON Incorporated.
 - 2) Insert manufacturer's name.
 - b. Source Limitations: Obtain flow meters from single source from single manufacturer.
 - c. Description:
 - 1) No moving parts.
 - 2) Suitable for flow measurement of fluids with electrical conductivity more than 5 micro-Seimens per cm.
 - 3) Inherent bi-directional flow measurement.
 - 4) Flow measurement with three pipe diameters upstream and two pipe diameters downstream.
 - 5) Wet calibrate and tag meters to standards traceable to NIST, and provide each meter with a certificate of calibration.
 - 6) Transmitter **[integral to] [remote from]** meter.
 - d. Performance:
 - 1) Accuracy for Velocities between 3.3 and 33 fps: Within 0.2 percent of reading.
 - 2) Accuracy for Velocities between 1.0 and 3.3 fps: Within 0.75 percent of reading.
 - 3) Accuracy for Velocities Less than 1.0 fps: Within 0.0075 fps.
 - 4) Ambient Temperature: Minus 4 to plus 140 deg F.
 - 5) Process Temperature: Minus 4 to plus 212 deg F.
 - 6) Pressure: 225 psig 580 psig.
 - e. Analog Output Current Signal:

- 1) Two-wire, 4- to 20-mA dc current source.
- 2) Signal capable of operating into 1000-ohm load.
- 3) Isolated.
- f. Digital Output Signal: Two, programmable, digital/pulse outputs configurable for frequency, pulse, or directional flow.
- g. Operator Interface:
 - 1) Keypad.
 - 2) Digital Display: Multiple-line digital display of alphanumeric characters.
 - 3) LED for normal and alarm operation.
- h. Construction:
 - 1) Body: Epoxy-coated carbon steel Type 316 stainless steel.
 - 2) Body Liner Material: PTFE Ebonite Polypropylene.
 - 3) Flow Tube: Type 304 stainless steel.
 - 4) Connection: 150 Class flange 300 Class flange Threaded Wafer.
 - 5) Electrodes: Type 316 stainless steel. Quantity determined by manufacturer based on application.
 - 6) Electronics Enclosure:
 - a) Painted aluminum.
 - b) Removable cover.
 - c) NEMA 250, Type 4 or Type 6.
3. Vortex Shedding Flow Meter with Integral Pressure and Temperature Measurement:
 - a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) ONICON Incorporated.
 - 2) Insert manufacturer's name.
 - b. Source Limitations: Obtain flow meters from single source from single manufacturer.
 - c. Description:
 - 1) Mass flow measurement corrected for density using vortex shedding body with integral piezoelectric pressure sensors and 1000-ohm platinum RTD.
 - 2) Meter NPS 1/2 through NPS 12.
 - 3) Each meter shall be factory calibrated at five points from 0 to 250 fps and tagged accordingly against manufacturer's flow standards. Manufacturer shall provide a certificate of calibration for meter.
 - 4) Each meter shall be programmed using Project-specific application data.
 - 5) Meter shall include integral diagnostics to verify installation conditions and proper operation.
 - d. Performance:
 - 1) Volumetric Flow Accuracy for Liquid: Within 0.75 percent of reading for Reynolds numbers 20000 and larger.
 - 2) Volumetric Flow Accuracy for Steam and Gas: Within 1 percent of reading for Reynolds numbers 20000 and larger.
 - 3) Mass Flow Accuracy for Steam and Gas: Within 1.5 percent of reading for Reynolds numbers 20000 and larger.
 - 4) Repeatability: Within 0.1 percent.
 - 5) Long-Term Stability: Within 0.1 percent per year.
 - 6) Ambient Temperature: Minus 40 to plus 185 deg F.
 - 7) Process Temperature: Minus 40 to plus 464 deg F.
 - 8) Pressure: Equal to flange rating.
 - e. Output Signals:

- 1) Analog Current Signal of Flow Rate:
 - a) Two-wire, 4- to 20-mA dc current source.
 - b) Signal capable of operating into 1000-ohm load.
 - 2) Analog Current Signals for Pressure and Temperature: Separate 4- to 20-mA signals for gauge pressure and temperature.
 - 3) Digital Signal:
 - a) Pulse output for flow totalization. Two wire, scaled pulse, 0.5 Hz, 100 mA at 30 V dc.
 - b) HART, FSK protocol.
- f. Operator Interface:
- 1) Keypad.
 - 2) Digital Display: Two-line digital display of alphanumeric characters. Meter shall display flow rate, flow totalization, pressure, temperature, and support field programming of all parameters.
- g. Construction:
- 1) Material: Type 316L stainless steel.
 - 2) Connection: Class 150 Class 300 Class 600 flange.
 - 3) Enclosure:
 - a) Epoxy-painted cast aluminum.
 - b) Removable screw-on cover.
 - c) NEMA 250, Type 4 or Type 6.
 - d) Electrical Connection: Screw terminals.
 - e) Conduit Connection: Two, 1/2-inch trade size.
- h. Upstream Flow Straightener:
- 1) Meter manufacturer shall provide flow straightener where required by installation to comply with manufacturer's written installation instructions.
 - 2) Straightener shall be wafer type, constructed of Type 304 stainless steel, designed to be installed between field-installed flanges.
 - 3) Straightener size shall match meter size.
- Q. Liquid Pressure Differential Switches:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Ashcroft Inc.
 - b. Insert manufacturer's name.
 2. Source Limitations: Obtain switches from single source from single manufacturer.
 3. Description:
 - a. Type 316 stainless steel double opposing bellows operate to actuate an SPDT snap switch.
 - b. Wetted Materials: Type 316 stainless steel.
 - c. Seal: Buna-N FKM.
 - d. Electrical Connections: Screw terminal.
 - e. Enclosure Conduit Connection: Knock-out or threaded connection.
 - f. User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.
 - g. High and Low Process Connections: Threaded, NPS 1/4.
 - h. Enclosure: NEMA 250, Type 4 or Type 4X.
 - i. Operating Data:
 - 1) Electrical Rating: 10 A at 120- to 240 V ac.
 - 2) Pressure Limits: 0 to 500 psig.

- 3) Ambient Temperature Limits: Minus 20 to plus 150 deg F.
- 4) Process Temperature Limits: 20 to 300 deg F.
- 5) Operating Range: 2 times set point unless otherwise required by application.
- 6) Deadband: Adjustable Fixed Adjustable or fixed as required by application.

j. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

R. Liquid Pressure Transmitters:

1. Liquid Gauge Pressure Transmitter with Adjustable Span:

a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**

- 1) Rosemount; Emerson Electric Co., Automation Solutions.
- 2) Insert manufacturer's name.

b. Source Limitations: Obtain transmitters from single source from single manufacturer.

c. Performance:

- 1) Range: Minus 300 to 300 psig.
- 2) Span: Field adjustable.
- 3) Minimum Span: 3 psig.
- 4) Reference Accuracy: Within 0.07 percent of span or better.
- 5) Stability: Within 0.125 percent of upper range limit for five years.
- 6) Overpressure Limits: 3626 psig.
- 7) Process Temperature Limits: Minus 40 to plus 250 deg F.
- 8) Ambient Temperature Limits: Minus 40 to plus 185 deg F.
- 9) Temperature Effect: Within 0.025 percent of upper range limit plus 0.125 percent of span.
- 10) Shock and vibration shall not harm the transmitter.

d. Analog Output Current Signal:

- 1) Two-wire, 4- to 20-mA dc current source.
- 2) Signal capable of operating into 1000-ohm load.
- 3) Digital signal based on HART protocol carried with current signal.
- 4) Dampening: Field selectable from zero to 30 seconds.

e. Operator Interface: Zero and span adjustments located behind cover.

f. Display: Digital, five-digit, two-line display with 0.4-inch- high, alphanumeric characters.

g. Construction:

- 1) Non-wetted parts of transmitter constructed of aluminum or stainless steel.
- 2) Enclosure with removable cover on each side.
- 3) Wetted parts of transmitter constructed of Type 316 stainless steel.
- 4) Threaded, NPS 1/2 process connection on bottom of instrument.
- 5) Drain/vent valve on process connection.
- 6) Two 1/2-inch trade size conduit connections on side of instrument enclosure.
- 7) Screw terminal block for wire connections.
- 8) NEMA 250, Type 4X.
- 9) Mounting Bracket: Appropriate for installation.

h. Three-Valve Manifold:

- 1) Include with each transmitter an integrally mounted manifold.
- 2) Construct manifold body of Type 316 stainless steel.
- 3) Manifold with threaded, NPS 1/2 female process connections.

2. Liquid, Pressure-Differential Transmitter with Adjustable Span:

- a. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - 1) Rosemount; Emerson Electric Co., Automation Solutions.
 - 2) Insert manufacturer's name.
 - b. Source Limitations: Obtain transmitters from single source from single manufacturer.
 - c. Performance:
 - 1) Range: Minus 300 to 300 psig.
 - 2) Span: Field adjustable.
 - 3) Minimum Span: 3 psig.
 - 4) Reference Accuracy: Within 0.07 percent of span or better.
 - 5) Stability: Within 0.125 percent of upper range limit for five years.
 - 6) Overpressure Limits: 3626 psig.
 - 7) Process Temperature Limits: Minus 40 to plus 250 deg F.
 - 8) Ambient Temperature Limits: Minus 40 to plus 185 deg F.
 - 9) Temperature Effect: Within 0.025 percent of upper range limit plus 0.125 percent of span.
 - 10) Shock and vibration shall not harm the transmitter.
 - d. Analog Output Current Signal:
 - 1) Two-wire, 4- to 20-mA dc current source.
 - 2) Signal capable of operating into 1000-ohm load.
 - 3) Digital signal based on HART protocol carried with current signal.
 - 4) Dampening: Field selectable from zero to 30 seconds.
 - e. Operator Interface: Zero and span adjustments located behind cover.
 - f. Display: Digital, five-digit, two-line display with 0.4-inch- high, alphanumeric characters.
 - g. Construction:
 - 1) Non-wetted parts of transmitter constructed of aluminum or stainless steel.
 - 2) Enclosure with removable cover on each side.
 - 3) Wetted parts of transmitter constructed of Type 316 stainless steel.
 - 4) Threaded, NPS 1/2 process connection on bottom of instrument.
 - 5) Drain/vent valve on process connection.
 - 6) Two 1/2-inch trade size conduit connections on side of instrument enclosure.
 - 7) Screw terminal block for wire connections.
 - 8) NEMA 250, Type 4X.
 - 9) Mounting Bracket: Appropriate for installation.
 - h. Five-Valve Manifold:
 - 1) Include with each transmitter an integrally mounted manifold.
 - 2) Construct manifold body of Type 316 stainless steel.
 - 3) Manifold with threaded, NPS 1/2 female process connections.
- S. Liquid Temperature Sensors:
- 1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Minco.
 - b. Insert manufacturer's name.
 - 2. Source Limitations: Obtain sensors from single source from single manufacturer.
 - 3. Resistance temperature (RTD) sensors shall comply with IEC 60751, Class B requirements.
 - 4. Platinum with a value of 100 ohms at 0 deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.

5. Encase RTD in a Type 316 stainless steel sheath with a 0.25-inch OD.
 6. Provide three-wire, PTFE-insulated, nickel-coated, 22-gauge, stranded copper leads.
 7. Provide spring-loaded RTDs for thermowell installations.
 8. Performance Characteristics:
 - a. Range: Minus 328 to plus 932 deg F.
 - b. Interchangeable Accuracy: Within 0.54 deg F at 32 deg F.
 - c. Stability: Within 0.05 percent maximum ice-point resistance shift after 1000 hours at 752 deg F.
 - d. Hysteresis: Within 0.04 percent of range.
 - e. Response Time: 62.8 percent of change in four seconds with water flowing across sensor at 3 fps.
 9. Thermowells:
 - a. Stem: Straight stepped tapered shank formed from solid bar stock.
 - b. Material: Type 304 Type 316 stainless steel.
 - c. Process Connection: Threaded, NPS 3/4.
 - d. Sensor Connection: Threaded, NPS 1/2.
 - e. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
 - f. Furnish thermowells installed in insulated pipes and equipment with an extended neck that extends beyond the face of the insulation covering.
 - g. Length: As required by application and pipe size.
 - h. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.
 10. Connection Heads:
 - a. Housing: Low-copper cast-aluminum alloy, complying with NEMA 250, Type 4.
 - b. Terminals: Six or eight as required by sensor.
 - c. Conduit Connection: 1/2-inch trade size.
 - d. Sensor Connection: NPS 1/2.
 11. Assembly: Sensor manufacturer shall furnish sensor, thermowell, and sensor connection head to provide a matched assembly.
- T. Liquid Temperature Transmitters:
1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Minco.
 - b. Insert manufacturer's name.
 2. Source Limitations: Obtain transmitters from single source from single manufacturer.
 3. Enclosure: House electronics in NEMA 250, Type 4 Type 4X enclosure.
 4. Enclosure Connection: 1/2-inch trade size.
 5. Functional Characteristics:
 - a. Input: 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, three-wire sensors.
 - b. Default Span (Adjustable):
 - 1) Chilled Water: 0 to 100 deg F.
 - 2) Heating Hot Water: 32 to 212 deg F.
 - 3) Insert system and span.
 - c. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
 - d. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
 - e. Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.

6. Performance Characteristics:
 - a. Calibration Accuracy: Within 0.1 percent of the span.
 - b. Stability: Within 0.2 percent of the span for at least six months.
 - c. Combined Accuracy: Within 0.5 percent.

- U. Control Transformers:
 1. Size each transformer for the total connected load, plus an additional 25 percent of the connected load.
 2. Each transformer shall be at least 100 VA.
 3. Provide transformer with both primary and secondary fuses.

- V. 25-V dc Power Supply:
 1. Plug-in style suitable for mating with a standard eight-pin octal socket.
 2. Enclose circuitry within a housing.
 3. Include line and load regulation to ensure a stable output. To protect both power supply and load, include power supply with an automatic current limiting circuit.
 4. Performance:
 - a. Output voltage nominally 25 V dc within 5 percent.
 - b. Output current up to 100 mA.
 - c. Input voltage nominally 120 V ac, 60 Hz.
 - d. Load regulation within 0.5 percent from 0- to 100-mA load.
 - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
 - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

- W. Instrument Identification:
 1. Engraved tag bearing instrument identification.
 - a. Each tag identifying an instrument shall have a unique identification that does not match identification of a similar device.
 - b. Tag field instruments identified by equipment being controlled or monitored, followed by point identification used on I/O schematics.
 - c. Example: DDC-AHU-01.01; PDIT1.
 2. Letter size shall be minimum 1/4 inch high.
 3. Letter type shall be sans serif gothic bold style.
 4. Lettering and background color scheme shall be white letters on black background.
 5. Tag shall be engraved phenolic constructed of three layers of pressure rigid laminate. Top and bottom layers are color-coded, contrasting white center is exposed by engraving through outer layer. Engrave both sides. Material shall be stain proof, heat resistant, non-conductive, or non-corrosive.
 6. Tag shall be fastened to equipment/instrument with drive pins or attached with a stainless steel chain.
 7. Instruments furnished with identification tags provided by original manufacturer do not require an additional tag.

- X. Checkout Procedures:
 1. Check instruments for proper location and accessibility.
 2. Check instruments for proper installation for direction of flow, elevation, orientation, and other applicable considerations.
 3. Damper Check-out: Verify that proper blade alignment, either parallel or opposed, has been provided.

- Y. Calibration and Adjustment:
 1. Calibrate every instrument.
 2. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.

3. Equipment and procedures used for calibration shall meet requirements of instrument manufacturer's written instructions. Test equipment used in calibration of instruments shall have an accuracy at least double that of instrument being calibrated.
4. Calibrate each instrument in accordance with the accuracy outlined in instruction manual supplied for instrument by manufacturer.
5. Control System Inputs and Outputs:
 - a. Check analog inputs using a precision voltage or current source at zero, 50, and 100 percent of span.
 - b. Check analog outputs using a milliampere meter at zero, 50, and 100 percent output.
 - c. Check digital inputs using a jumper wire.
 - d. Check digital outputs using an ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at zero, 50, and 100 percent of span using a precision-resistant source.
6. Flow: Set differential pressure flow transmitters for zero and 100 percent values with three-point calibration accomplished at 100, 50, and 90 percent of span.
7. Gas: Calibrate gas transmitters at zero, 50, and 100 percent of span.
8. Humidity: Calibrate relative humidity transmitters at zero, 50, and 100 percent of span.
9. Pressure: Calibrate pressure transmitters at zero, 50, and 100 percent of span.
10. Temperature: Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.
11. Dampers: Stroke and adjust control dampers following the recommended procedure from manufacturer, such that damper is 100 percent open and closed.
12. Replace out of tolerance instruments failing the test.
13. Provide diagnostic and test instruments for calibration and adjustment.

2.23 SMOKE DETECTORS

- A. System, Duct Smoke Detectors: For connection to conventional fire-alarm system. Coordinate requirements with Section 284621.13 "Conventional Fire Alarm System."
 1. Operating at 24-V dc, nominal.
 2. Detectors shall be **[four] [two]**-wire type.
 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 5. Integral Visual-Indicating Light: LED type, indicating detector has operated[**and power-on status**].
 6. Provide multiple levels of detection sensitivity for each sensor[**with alarm-verification feature**].
 7. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - a. Remote indication[**and test**] station.[**Operating key switch initiates an alarm test.**]
 - b. Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC systems.
 - c. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific size, air velocity, and installation conditions where applied.
 - d. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
- B. Nonsystem, Single-Station Duct Smoke Detectors:
 1. Nonsystem smoke detectors shall be listed as compatible with fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
 2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.
 3. Comply with UL 268A; operating at 120 V ac.
 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to mounting brackets air-handling unit. Provide terminals in the fixed base for connection to building wiring.

- a. Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.
 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific size, air velocity, and installation conditions where applied.
 6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
- C. Air-Handling Unit Factory Assembly:
1. Furnish and install smoke detectors inside air-handling units to comply with governing building codes.
 2. Install smoke detectors in accordance with smoke detector manufacturer's written installation instructions.
 - a. Sampling tubes shall extend the full width of airstream.
 - b. Sampling tubes greater than 36 inches long shall be supported on both ends.
 3. Install smoke detectors within air-handling units in a location that is easily accessible for inspection, repair, and replacement of smoke detector, and in a location that does not hinder access to other internal components.
- D. Air-Handling Unit Factory Testing: Functionally test smoke detectors to ensure proper operation in accordance with smoke detector manufacturer's written instructions.
- E. Air-Handling Unit Factory Installation of Addressable Smoke Detectors Furnished by Building Fire-Alarm System Supplier:
1. Where addressable duct smoke detectors are indicated to be installed within air-handling unit casing, air-handling unit manufacturer shall install duct smoke detector components supplied by building fire-alarm system supplier.
 2. Mount duct smoke detector sampling housing on exterior of air-handling unit casing. Locate on accessible side and coordinate with installers before installation.
 3. Seal air-handling unit casing penetrations.
 4. Install duct smoke detector components in accordance with written instructions furnished by supplier.
 - a. Sampling tubes shall extend the full width of airstream.
 - b. Sampling tubes greater than 36 inches long shall be supported on both ends.
 5. Photograph installation and transmit photos to fire-alarm system Installer before air-handling unit shipment to ensure proper installation. Fire-alarm system Installer shall review photos and provide written acceptance of installation to air-handling unit manufacturer before air-handling unit shipment.
 - a. Document date of photos and approval for record purposes.
 - b. Make corrective measures required by fire-alarm system Installer as required for acceptance.
 6. Coordinate work schedule of air-handling unit manufacturer and fire-alarm system supplier to meet requirements of Project schedule.
 7. See [Section 284621.11 "Addressable Fire-Alarm Systems"] <Insert Section> for additional requirements.

2.24 HARDWARE

- A. Screws:
1. For Galvanized-Steel Materials: Self-tapping, hex-head, zinc-plate steel 300 series stainless steel screws with a neoprene gasket encapsulated by a zinc-plate steel 300 series stainless steel washer.
 2. For Aluminum and Stainless Steel Materials: Self-tapping, hex-head, 300 series stainless steel screws with a neoprene gasket encapsulated by a 300 series stainless steel washer.
 3. Provide protective covers on exposed screws to prevent personnel injury.

B. Bolts, Nuts, and Washers:

1. For Joining Galvanized and Painted Carbon-Steel Materials: Hex-head, high-strength, galvanized steel 300 series stainless steel.
2. For Joining Aluminum and Stainless Steel Materials: Hex-head, high-strength, 300 series stainless steel.
3. Use washers and lock washers at each bolted connection.
4. Select bolt size and spacing sufficient for load and application.

2.25 WELDING

A. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.

1. Use welding materials with corrosion properties equal to material being welded.

B. Use welders that are certified to weld at least [**twice**] the thickness of the material to be welded. Certification shall be within [**three**] [**six**] **<Insert number>** months of work being performed.

C. Welds shall be continuous, full-penetration welds unless otherwise indicated. Intermittent welds, stitch welds and tack welds are permitted only in specific applications indicated.

D. Use welders and welding procedures complying with the following:

1. Piping Systems: Section IX of the ASME Boiler and Pressure Vessel Code and Section V of ASME B31.1.
2. Structural Aluminum: AWS D1.2/D1.2M.
3. Structural Carbon Steel: AWS D1.1/D1.1M.
4. Structural Stainless Steel: AWS D1.6/D1.6M.
5. Sheetmetal: AWS D9.1/D9.1M.

2.26 PAINTING

A. General:

1. Painted OEM components do not require additional coating other than touch-up to damaged areas. Match the touchup coating to surrounding undamaged surfaces.
2. Finish miscellaneous surfaces to match continuous surfaces.
3. Protect mill galvanized surfaces that are exposed to view, such as raw steel cuts and damage by welding, with multiple coats of matching galvanized paint.
4. Protect mill galvanized surfaces that are concealed, such as raw steel cuts and damage by welding, with multiple coats of zinc-rich paint or matching galvanized paint.
5. Touch up or entirely repaint surface finishes, damaged during shipment and installation, to the original condition, using original materials and methods.

B. Preparation:

1. Submit proposed manufacturer's written preparation and application instructions for information.
2. If paint manufacturer's recommended preparation requirements differ from those indicated, use the more stringent requirements.
3. Structural carbon steel to be painted shall be deburred, ground smooth, cleaned, and blasted in accordance with SSPC-SP 6/NACE No. 3 SSPC-SP 10/NACE No. 5.
4. Before applying a primer and a finish coat, remove oil and grease from surfaces to be coated using clean rags soaked in thinner in accordance with SSPC-SP 1.
5. Treat surfaces to be painted to ensure that paint adheres.

C. Primer:

1. Rust-inhibiting type, with a minimum dry film thickness of 1 2 Insert value mil(s) per coat.

2. Apply at least two Insert number coats of primer to unfinished carbon-steel surfaces and at least one coat of primer to other surfaces.
3. Use primer that is compatible with substrate and finish coat.

D. Finish Coat:

1. Finish coat painting system shall be alkyd-enamel epoxy polyurethane Insert coating.
2. Use dry film thickness recommended by paint manufacturer for each coat. Total dry film thickness of all finish coats not less than 3 5 Insert value mils.
3. Painted Surfaces Minimum Properties:
 - a. Salt Spray ASTM B117: 5 percent salt solution fog at 95 deg F for 1000 2000 4000 Insert value hours with no deterioration.
 - b. Adhesion, ASTM D3359: When the coating is cut into 0.0625-inch squares and 3M No. 600 tape is suddenly removed, there is no loss of adhesion.
 - c. Acid Resistance ASTM D3260: 15-minute exposure to 10 percent hydrochloric acid at room temperature with no effect.
 - d. Alkali Resistance ASTM D1647: 15-minute exposure to 10 percent sodium hydroxide at room temperature with no effect.
 - e. Humidity Resistance ASTM D2247: 850-hour exposure to 100 deg F and at least 95 percent relative humidity with no effect.
 - f. Pencil Hardness ASTM D3363: A hardness of 1H.
4. Finish coat color shall be selected by Architect and not be limited to manufacturer's standard offering.
 - a. Submit a written request for color selection and indicate in the request the date color selection must be returned without impacting schedule.

E. Application: Paint the following surfaces with primer and finish coat indicated:

1. Unfinished carbon-steel surfaces.
2. Exposed mill galvanized-steel surfaces of air-handling unit casing exterior.
3. Exposed aluminum surfaces of air-handling unit casing exterior.
4. Exposed stainless steel surfaces of air-handling unit casing exterior.

2.27 CLEANLINESS REQUIREMENTS

A. General:

1. Provide equipment that has been manufactured, shipped, stored, and installed maintaining highest degree of cleanliness possible.
2. Owner Cleanliness Inspection: Air-handling unit(s) cleanliness is subject to Owner cleanliness inspection [**and must pass a white glove test**] before packaging for shipment.
3. **<Insert requirements>**.

B. During Manufacturing:

1. Clean materials to be free of mill grease, oxidation, dirt, dust, and other impurities before manufacturing and assembly.
2. Protect casing materials from contamination during manufacturing and assembly.
3. Use sealing materials that do not outgas.
4. Provide OEM components and equipment from their respective manufacturers free of grease, oxidation, and dirt. Store OEM components and equipment indoors. Cover and protect OEM components and equipment to maintain cleanliness. Follow OEM instructions for equipment storage.

C. After Manufacturing:

1. Before shipment, after unit is completely assembled, clean unit inside and out.

- a. Vacuum entire inside to remove dirt, dust, and debris using HEPA-filtered vacuum equipment.
 - b. Purge hard to reach surfaces with dry, oil-free, compressed or bottled nitrogen.
 - c. Wipe down all surfaces, inside and out, with a residue-free cleaning agent.
2. Protect unit to maintain cleanliness.
- D. Shipping:
1. Protect interior and exterior of air-handling unit from exposure to weather dirt, dust, and debris during shipment and rigging.
 2. Cover openings with puncture-resistant durable coverings to ensure that cleanliness is maintained inside unit while providing an air- and watertight seal.
- E. On-Site Storage:
1. If air-handling unit is to be stored before installation, Installer shall work closely with air-handling unit manufacturer for air-handling unit manufacturer to provide adequate protection at the factory to ensure that cleanliness for both unit interior and unit exterior is maintained. This protection shall remain in place until unit startup is performed.
 2. For extended periods of storage, provide a means to rotate fan and motor assemblies on a periodic basis (as recommended in writing by manufacturer) without compromising unit cleanliness.

2.28 ACCESSORIES

- A. Tool Kit:
1. Manufacturer shall assemble a tool kit specially designed for use in servicing air-handling units furnished.
 2. Include only special tools required to service air-handling unit components not readily available for purchase by Owner service personnel in performing routine maintenance.
 3. Place tools in a lockable case with hinged cover.
 4. Mark case cover with large and permanent text to indicate special purpose of tool kit, such as "Air-Handling Unit Tool Kit." Text size shall be at least [1 inch] <Insert dimension> high.
 5. Provide a list of each tool furnished and permanently attach the list to underside of case cover. Text size shall be at least [1 inch] <Insert dimension> high.

2.29 SOURCE QUALITY CONTROL

- A. AHRI Compliance:
1. AHRI 260 (I-P): Air-handling unit sound ratings shall be in accordance with AHRI 260 (I-P), "Sound Rating of Ducted Air Moving and Conditioning Equipment."
 2. AHRI 261 (SI): Air-handling unit sound ratings shall be in accordance with AHRI 261 (SI), "Sound Rating of Ducted Air Moving and Conditioning Equipment."
 3. AHRI 410: Air-handling unit coils shall be rated in accordance with AHRI 410 and shall be listed by AHRI[**and labeled in accordance with AHRI**].
 4. AHRI 1060 (I-P) Certification: Air-handling units that include [energy wheels] [fixed plate heat exchangers] [and] [heat pipe heat exchangers] shall be rated in accordance with AHRI 1060 (I-P) and shall be listed by AHRI[**and labeled in accordance with AHRI**].
 5. AHRI 1061 (SI) Certification: Air-handling units that include [energy wheels] [fixed plate heat exchangers] [and] [heat pipe heat exchangers] shall be rated in accordance with AHRI 1061 (SI) and shall be listed by AHRI[**and labeled in accordance with AHRI**].
- B. AMCA Compliance:
1. AMCA 201: Air-handling unit manufacturer shall evaluate fan's performance within the air-handling unit in accordance with AMCA 201, "Fans and Systems" and account for conditions within the air-handling unit that could be detrimental to fan's performance by adjusting the fan performance indicated on Drawings.

2. AMCA 205 Certification: Air-handling unit fan's fan efficiency grade (FEG) shall be rated in accordance with AMCA 205, "Energy Efficiency Classifications for Fans"[**and shall bear the AMCA-certified fan efficiency grade seal**].
 3. AMCA 210 Certification: Air-handling unit fan's air performance shall be rated in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"[**and shall bear the AMCA-certified air ratings seal**].
 4. AMCA 300: Air-handling unit fan's sound performance shall be rated in accordance with AMCA 300, "Reverberant Room Method for Sound Testing of Fans."
 5. AMCA 301 Certification: Air-handling unit fans sound performance shall be rated in accordance with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data"[**and shall bear the AMCA-certified sound ratings seal**].
 6. AMCA 500-D: Air-handling unit damper's performance shall be rated in accordance with AMCA 500-D, "Laboratory Methods of Testing Dampers for Rating"[**and shall bear the AMCA-certified air ratings seal**].
- C. NFPA Compliance:
1. NFPA 70: Electrical components, devices, and accessories shall be listed and labeled by a qualified testing agency, and marked for intended location and application.
 2. NFPA 90A: Design, fabrication, and installation of air-handling units and components shall comply with NFPA 90A.
- D. UL Compliance:
1. UL 1598 Certification: Air-handling unit UVGI shall be NRTL listed and labeled in accordance with UL 1598, "Luminaires."
 2. UL 1995 Certification: Where indicated, air-handling unit components shall be NRTL listed and labeled in accordance with UL 1995, "Standard for Safety Heating and Cooling Equipment."

2.30 SOURCE QUALITY CONTROL - INDEPENDENT LABORATORY TESTING

- A. General:
1. Project-specific testing by an independent laboratory is not required if air-handling unit manufacturer has written independent laboratory test results of past tests performed on same casing construction proposed for use on this Project.
 2. If Project-specific testing is required, testing shall be performed in ample time to include test reports with submittals and before manufacturing of air-handling units. Include sufficient lead time for unit delivery, installation, and testing required by construction schedule.
- B. Casing Structural Deflection Test:
1. Include service of an independent testing laboratory to verify casing structural deflection requirements indicated.
 - a. In lieu of independent laboratory testing, manufacturer may perform factory deflection testing of proposed construction to prove compliance if witnessed by **[Architect] [and] [Owner]**. Manufacturer shall bear cost of labor and travel expenses to witness testing.
 2. Test casing construction to performance criteria indicated.
 3. Test casing construction proposed for use on Project. Include, at a minimum, particulars such as metal materials and thickness, internal support and reinforcing, and insulation material and thickness.
 4. Test largest full-size casing panel proposed for use on Project.
 5. Test proposed construction of walls, floor, and roof. Include a separate test for each unique casing construction proposed.
 6. Submit test reports for each test to show compliance with performance indicated.
- C. Casing Airborne Sound Transmission Test:

1. Include services of an independent testing laboratory to test proposed casing construction for sound transmission. Include a separate test for each unique casing construction proposed.
2. Conduct tests in accordance with ASTM E90.
3. Determine sound transmission class by using ASTM E413.
4. Test proposed construction of walls and roof.
5. Test proposed construction of floor assembly only if air-handling unit is not installed on a concrete housekeeping pad or building structural floor.
6. Submit test reports for each test to show compliance with performance indicated.

D. Casing Sound Absorption Test:

1. Include services of an independent testing laboratory to verify casing sound absorption coefficients for perforated casing panels. Provide a separate test for each unique casing construction proposed.
2. Conduct tests in accordance with ASTM C423 and ASTM E795.
3. Test proposed construction of walls and roof.
4. Submit test reports to show compliance with performance indicated.

2.31 SOURCE QUALITY CONTROL - AIR-HANDLING UNIT FACTORY TESTS

A. Witness of Testing: Allow **[Architect] [Commissioning Agent] [Construction Manager] [and] [Owner]** **<Insert entity>** access to place where air-handling units are being tested for witness testing.

1. Submit written notification at least **[30] [20] <Insert number>** days in advance of testing.
2. Schedule testing at mutually agreeable dates and times.

B. Witness Testing Travel Expenses:

1. Include in bid the cost of travel expenses to witness factory testing. Total cost for travel expenses shall be clearly indicated separately in bid.
2. Expenses shall include roundtrip **[coach] [or] [first]** class airfare, out-of-town hotel accommodations, out-of-town meals (breakfast, lunch, and dinner), out-of-town ground transportation and parking, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for **[one] [two] <Insert value>** representative(s) with origin of **<Insert city and state>**.

C. Casing Leakage Test:

1. Perform a leak test for **[each assembled air-handling unit] [each assembled air-handling unit of unique size and arrangement] <Insert requirement>**.
2. Follow testing procedures in accordance with ASHRAE 111.
3. Perform leak test before shipping first air-handling unit **[of unique size and arrangement]**.
4. Test results shall indicate that units comply with leakage requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
5. Prepare test reports in accordance with ASHRAE 111.
6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

D. Casing Structural Deflection Test:

1. Perform a structural deflection test for **[each assembled air-handling unit] [each assembled air-handling unit of unique size and arrangement] [only one air-handling unit with the worst-case condition] <Insert requirement>**.
2. Pressurize and load air-handling units to the performance criteria indicated for structural deflection. Test air-handling unit **[floors] [walls and roofs]**.

3. Test results shall indicate that units comply with deflection requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
4. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

E. Functional Run Test:

1. Run test each unit before shipment.
2. Test and balance fans to comply with vibration requirements indicated.
3. Energize each electrical device to ensure it is operational.
 - a. Take meter readings for volts, amperes, and kVAR on each phase leg of each motor.
 - b. Take meter readings for volts, amperes, and kVAR on each single-phase power connection to field power.
4. Exercise each damper to ensure proper operation.
5. Exercise each access door to ensure proper fit.
6. Exercise each valve to ensure proper operation.
7. Submit a written report for each unit tested. Written report shall include, at a minimum, full name of each person witnessing test, detailed list of each unit component tested, condition observed, and corrective action required. Each line item shall have full name of the person doing the checkout and date and time the checkout was performed.

F. Fan Vibration Test:

1. Perform a fan vibration test for **[each assembled air-handling unit] [each assembled air-handling unit of unique size and performance] <Insert requirement>**.
2. Energize each fan within the air-handling unit after air-handling unit final assembly and perform a vibration analysis with fan operating at design speed **[and at all speeds throughout the range from design to minimum speed]**.
3. Three vibration measurements shall be taken for each bearing in horizontal, vertical, and axial directions. Vibration measurements shall be recorded and consist of vibration amplitude verses frequency **[with filter-in]**.
4. Fan bearing measurement points shall be marked or scribed on bearings for permanent record.
5. Test results shall indicate that units comply with vibration requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

G. Acoustical Performance Test:

1. Perform an acoustical performance test for **[each assembled air-handling unit] [each assembled air-handling unit of unique size and performance] <Insert requirement>**.
2. Air-handling unit acoustic performance shall be verified by factory test in accordance with AHRI 260 (I-P) or AHRI 261 (SI).
3. Air-handling unit supply-air discharge, return-air inlet, and casing radiated sound components shall be measured with air-handling unit operating at design conditions.
4. Testing Location: Perform testing in a location complying with AHRI 220, "Reverberation Room Qualification and Testing Procedures for Determining Sound Power of HVAC Equipment."
 - a. Test location shall be broadband qualified in accordance with AHRI 220 Section 5.1 and discrete frequency qualified in accordance with Section 5.2.

5. Operating conditions used in acoustic testing shall be verified by test in accordance with AMCA 210[**in an AMCA-accredited facility**].
 6. Test results shall indicate that units comply with acoustical requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
 7. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.
- H. Airflow Capacity Performance Test:
1. Perform an airflow capacity performance test for **[each assembled air-handling unit] [each assembled air-handling unit of unique size and performance] <Insert requirement>**.
 2. Operating conditions shall be verified by test in accordance with AMCA 210[**in an AMCA-accredited facility**].
 3. Test results shall indicate that units comply with design airflow requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
 4. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.
- I. Hydronic Piping Systems Testing: Pressure test factory-assembled piping systems with compressed air or water at a pressure to comply with governing codes and ASME B31.9, but not less than design pressure indicated.
1. Test results shall indicate that piping systems are without leaks. Make changes to noncompliant piping systems and retest until units comply with requirements.
 2. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.
- J. Steam and Condensate Piping Systems Testing: Pressure test factory-assembled piping systems with compressed air or water at a pressure to comply with governing codes and ASME B31.1 or ASME B31.9 as applicable for service, but not less than design pressure indicated.
1. Test results shall indicate that piping systems are without leaks. Make changes to noncompliant piping systems and retest until units comply with requirements.
 2. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

2.32 SOURCE QUALITY CONTROL - OEM COMPONENT FACTORY TESTS

- A. Air Blender Testing:
1. Owner-witnessed performance test to demonstrate compliance with performance requirements indicated.

- B. Coil Testing:
1. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than [300-psig] <Insert pressure> internal pressure.
 2. Refrigerant Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than [300-psig] <Insert pressure> internal pressure.
 3. Steam Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than to [300-psig] <Insert pressure> internal pressure.
 4. Coils to display a tag with inspector's identification as proof of testing.
- C. Fan Vibration Testing:
1. Perform a fan vibration test for [each fan] <Insert requirement>.
 2. Energize each fan after final assembly and perform a vibration analysis with fan operating at design speed[**and at all speeds throughout the range from design to minimum speed**].
 3. Three vibration measurements shall be taken for each bearing in the, vertical, and axial directions. Vibration measurements shall be recorded and consist of vibration amplitude verses frequency[**with filter-in**].
 4. Fan bearing measurement points shall be marked or scribed on bearings for permanent record.
 5. Test results shall indicate units comply with vibration requirements indicated. Make changes to noncompliant fans and retest until fans comply with requirements.
 6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single fan, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine air-handling units before installation. Reject units with physical damage, and air-handling unit components that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for the following before installation of air-handling units:
1. Structural substrate mounting and anchorage to verify actual sizes, types, and locations.
 2. Piping systems to verify actual sizes, types, and locations of connections.
 3. Ductwork and plenums to verify actual sizes, types, and locations of connections.
 4. Electrical services and controls to verify actual sizes, types, and locations of connections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF OUTDOOR, CUSTOM AIR-HANDLING UNITS

- A. Equipment Mounting: Install air-handling units at locations indicated on Drawings. Unless, otherwise indicated on Drawings, install air-handling units on concrete equipment bases.
1. Units Mounted on Concrete Bases:
 - a. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

- b. Level air-handling unit bases using aluminum or stainless steel shims compatible with air-handling unit base material.
 - c. Fill voids between air-handling unit bases and concrete bases using high-strength non-shrink grout.
 - d. Continuously seal between concrete bases and perimeter of air-handling unit bases with nonhardening sealant.
 2. Units Mounted to Structural-Steel Supports: Level unit air-handling bases using aluminum or stainless steel shims compatible with air-handling unit base material. Continuously seal between structural supports and air-handling unit bases with nonhardening sealant.
 3. Units Mounted Directly to Finished Floors: Level air-handling unit bases using aluminum or stainless steel shims compatible with air-handling unit base material. Continuously seal between floor and perimeter of air-handling unit bases with nonhardening sealant.
 4. Suspended Units: Suspend and laterally brace air-handling units from building structure by attaching to only air-handling unit bases at manufacturer-designated locations.
 5. Install air-handling units on curbs following air-handling unit manufacturer's written procedures.
 - a. Install gaskets before setting air-handling units on curbs.
 - b. Secure air-handling units to curbs using stainless steel fasteners.
 - c. Install curb and fasten to structure.
 - d. Coordinate curb requirements, attachment, and location before installation.
- B. Roof Openings:
 1. Provide exact size and location of roof openings to trade installing structural framing and roof structure.
 2. Supervise framing of openings to ensure coordinated installation with air-handling units.
- C. Seismic Control: Comply with requirements for seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- D. Equipment Clearances and Access:
 1. Arrange installation of air-handling units to provide access space around air-handling units for service and maintenance and for removal and replacement of internal components.
 2. Provide clearance and access required by governing codes and NFPA 70.
 3. At a minimum, comply with requirements indicated on Drawings and air-handling unit manufacturer's written instructions.

3.3 PROTECTION DURING CONSTRUCTION

- A. Exterior Covers: Cover air-handling units during construction with sealed covers to protect air-handling unit casing and externally mounted components from physical damage, dirt, dust and debris, paint splatter, and any other construction materials.
 1. Minor physical damage, as determined by Owner, shall be repaired by air-handling unit factory service personnel to factory-finished condition.
 2. Replace air-handling units with damage that in any way compromises the performance indicated.
- B. Internal Access: Keep access doors locked to maximum extent possible and restrict access to only authorized personnel.
 1. Open access doors only during periods authorized work inside air-handling units is required.
 2. Coordinate and monitor work inside air-handling units on a shift basis. Lock access doors once work is complete or at the end of each shift.
 3. Immediately report unauthorized access and any observed damage to Owner.

3.4 DUCT CONNECTIONS

- A. Connect ducts and plenums to air-handling unit connections. Comply with requirements in Section 233113 "Metal Ducts."
- B. Connect ducts and plenums to air-handling unit connections with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."
- C. Provide duct transitions required to make field connections to air-handling units.
- D. Arrange ducts and plenums to provide unobstructed access to inside of air-handling units.

3.5 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to air-handling unit, provide unobstructed access to inside of air-handling units for service and maintenance.
- C. Connect piping to air-handling units with flexible connectors.
- D. Drain Pan Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping."
 - 1. Make connections to air-handling unit connections with **[flanges or]**unions.
 - 2. Extend **[dedicated]**drain piping from each air-handling unit connection to nearest equipment or floor drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.
 - 3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.
 - 4. Install threaded cleanouts at changes in direction.
 - 5. Secure drain piping to structure.
- E. Air-Handling Unit Floor Drains: Do not require installation of permanent drain piping.
- F. Air-Handling Unit Floor Drain Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping."
 - 1. Make connections to air-handling unit connections with **[flanges or]**unions.
 - 2. Extend **[dedicated]**drain piping from each air-handling unit connection to nearest equipment or floor drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.
 - 3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.
 - 4. Install threaded cleanouts at changes in direction.
 - 5. Secure drain piping to structure.
- G. Chilled-Water Coil Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
 - 1. Comply with requirements indicated on Drawings.
 - 2. Make connections to coils with a **[flange] [or] [union]**.
 - 3. Connect to each coil inlet with shutoff valve, test plug, **[pressure gauge] [and] [thermometer]**.
 - 4. Connect to each coil outlet with balancing valve, test plug, **[pressure gauge] [thermometer] [flow meter] [and] [shutoff valve]**.
 - 5. Connect each coil drain connection with a drain valve, which is full size of drain connection.**[Connect drain pipe to drain valve with union, and extend drain pipe to terminate over floor drain.]**

6. Connect each coil vent connection with **[automatic] [or] [manual]** vent, which is full size of vent connection.

- H. Hot-Water Coil Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
 1. Comply with requirements indicated on Drawings.
 2. Make connections to coils with a **[flange] [or] [union]**.
 3. Connect to each coil inlet with shutoff valve, test plug, **[pressure gauge] [and] [thermometer]**.
 4. Connect to each coil outlet with balancing valve, test plug, **[pressure gauge] [thermometer] [flow meter] [and] [shutoff valve]**.
 5. Connect each coil drain connection with a drain valve, which is full size of drain connection. **Connect drain pipe to drain valve with union, and extend drain pipe to terminate over floor drain.**
 6. Connect each coil vent connection with **[automatic] [or] [manual]** vent, which is full size of vent connection.

- I. Steam and Condensate Coil Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap assembly, and union or flange at each coil return connection.

- J. Refrigerant Coil Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve at each supply and return connection.

- K. Steam Humidifier Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install gate valve and inlet strainer at supply connection of steam humidifiers and steam trap assemblies to condensate return connection.

3.6 ELECTRICAL CONNECTIONS

- A. Install field power to each air-handling unit electrical power connection. Coordinate with air-handling unit manufacturer and installers.

- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

- D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [1/2 inch] **<Insert dimension>** high.

3.7 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [1/2 inch] <Insert dimension> high.

3.8 STARTUP SERVICE

- A. Engage an air-handling unit factory[-authorized] service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, controls, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - 6. Verify that face-and-bypass dampers provide full face flow.
 - 7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 - 8. Comb coil fins for parallel orientation.
 - 9. Verify that proper thermal-overload protection is installed for electric heaters.
 - 10. Install new, clean filters.
 - 11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
 - 12. <Insert requirement>.
- B. Starting procedures for air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. [**Replace fan and motor pulleys as required to achieve design conditions.**]
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.
 - 4. <Insert requirement>.
- C. Heat Wheel Startup Service:
 - 1. After field installation is complete, a final checkout and startup shall be completed to ensure proper purge adjustment, seal adjustment, control settings, and other key operational functions.
 - 2. Service shall be completed by trained factory service personnel employed by heat wheel manufacturer.
 - 3. Submit a report summarizing findings, adjustments made, and final settings.

3.9 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
- C. Before turning equipment over to Owner for use, adjust air-handling unit components that require further adjustment for proper operation. Consult air-handling unit manufacturer for instruction.

- D. Occupancy Adjustments: When requested within [12] <Insert number> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other-than-normal occupancy hours for this purpose.
- E. Seasonal Adjustments: Make seasonal visits during warranty period to inspect and review operation of equipment. Make necessary adjustments for components observed to require adjustments for proper operation. Prepare and submit a report to Owner documenting each visit, observations, and any adjustments made.

3.10 CLEANING

- A. Cleaning Schedule: After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems, and after completing startup service, and immediately before Owner use, clean air-handling units to remove foreign material and construction dirt and dust.
- B. Unit Interior: Clean air-handling units internally to factory clean condition. Remove foreign material and construction debris, dirt, and dust.
 - 1. Vacuum clean with HEPA-filtered vacuum and then wipe down with cleaning solution.
 - 2. Clean casing floors, roofs, wall surfaces, access doors, and panels.
 - 3. Clean all internal components, such as, coils, dampers, filter frames, fans, and motors.
 - 4. Clean light fixtures and control devices.
- C. Unit Exterior: Clean external surfaces of air-handling units to factory clean condition. Remove foreign material and construction debris, dirt and dust. Vacuum clean with HEPA-filtered vacuum and then wipe down all surfaces with cleaning solution.
- D. Cleaning Materials: Use cleaning materials and products recommended in writing by air-handling unit manufacturer.
- E. Acceptance: Following unit cleaning submit a written request for review and [Owner]acceptance. Acceptance for cleaning of air-handling units [with absolute filters]must pass a white glove test.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections: Perform the following tests and inspections[with the assistance of a factory-authorized service representative].
 - 1. After field piping connections are complete, test [hydraulic] [and] [steam] coils and connections for leaks.
 - 2. Charge refrigerant coils with refrigerant and test for leaks.
 - 3. Field-Assembly Supervision: Instruct Installer and supervise field installation of [first] <Insert quantity> air-handling unit(s) shipped in multiple pieces for field assembly.
 - 4. Roof-Mounted Field-Installation Supervision: Instruct Installer and supervise field installation of [first] <Insert quantity> roof-mounted air-handling unit(s).
 - 5. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Field Casing Leakage Test:

1. Perform leak testing of air-handling units that include field assembly of multiple sections. Air-handling units that are shipped and installed as a single piece do not require field testing.
2. Leak test **[one]** **<Insert value>** air-handling unit(s) of each unique size and arrangement randomly selected by **[Architect]** **[Commissioning Agent]** **[Owner]**.
3. Follow procedures complying with ASHRAE 111.
4. Assembled air-handling units shall satisfy leakage criteria indicated. Modify air-handling units that fail to satisfy criteria and retest. For every air-handling unit that fails test, another air-handling unit shall be tested until all air-handling units tested pass leakage criteria on first attempt.
5. Submit a test report for each test indicating test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.
6. Test report shall be in accordance with ASHRAE 111.
7. Witness Testing:
 - a. Provide written notification at least **[30]** **[20]** **<Insert number>** business days in advance of testing.
 - b. Testing shall be conducted in presence of testing and balancing agent.
 - c. Other parties such as Architect, Commissioning Agent, and Owner shall be invited to witness testing with attendance being optional.

E. Field Fan Vibration Test:

1. Perform fan vibration testing for every one out of **[10]** **<Insert number>** air-handling unit fans randomly selected by **[Architect]** **[Commissioning Agent]** **[Owner]**.
2. Test after air-handling unit installation is complete.
3. Three vibration readings shall be taken for each bearing in horizontal, vertical, and axial directions. Record each reading including vibration amplitude versus frequency.
4. Modify fans that fail to satisfy performance criteria and retest. For every fan that fails test, another fan shall be tested until all fans tested pass criteria on first attempt.
5. Submit a report for each fan tested indicating air-handling unit designation, fan designation, test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.
6. Witness Testing:
 - a. Provide written notification at least **[30]** **[20]** **<Insert number>** business days in advance of testing.
 - b. Testing shall be conducted in presence of testing and balancing agent.
 - c. Other parties such as Commissioning Agent, Architect, and Owner shall be invited to witness testing with attendance being optional.

F. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

G. Prepare test and inspection reports.

3.12 OPERATION DURING CONSTRUCTION

A. Operation of air-handling units for temporary cooling, heating, and ventilation is not allowed without Owner authorization.

1. Submit written request for Owner approval by signature with detailed description of operating procedures to be followed including, but not limited to, the following:
 - a. Description of construction activities while units are operating.
 - b. Operation:
 - 1) Beginning and ending calendar dates.
 - 2) List each day during week.
 - 3) List start and stop time and hours for each day.
 - c. Startup procedures and shut-down procedures.
 - d. Provisions for routine monitoring of unit operation.

- e. Provisions to prevent and protect against damage to equipment due to adverse operation such as, low temperature, high temperature, over pressure, fire, smoke, electrical over- and undervoltage and current and electrical fault.
 - f. Provisions and safeguards for filtration to keep inside of units from getting dirty.
 - g. Record keeping.
2. If approved by Owner, units used for temporary cooling, heating, and ventilation during and before interior finish work is complete shall include an unconditional complete unit labor and parts warranty to extend at least two years after the warranty indicated expires.
 3. Interior and exterior of air-handling units shall be cleaned to a factory-cleaned condition and clean condition must be accepted by Owner.
- B. Filtration During Temporary Use:
1. Protect air-handling system ducts (exhaust air, outdoor air, and return air) with temporary filters installed and supported to prevent filter media from collapse and bypass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 8 in accordance with ASHRAE 52.2.
 2. Protect air-handling units with open inlets that are not ducted with temporary filters installed and supported to prevent filter media from collapse and by-pass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 8 in accordance with ASHRAE 52.2.
 3. Do not operate air-handling units until both temporary and scheduled permanent air-handling unit particulate filters are in place. Temporary filters must be installed upstream of permanent filters while units are operating.
 4. Replace temporary and permanent filters used during construction when dirty. After end of temporary use, replace permanent filters with new, clean filters before beginning testing, adjusting and balancing.
- C. Comply with SMACNA 008, "IAQ Guidelines for Occupied Buildings under Construction," for procedures to protect HVAC system.

3.13 DEMONSTRATION

- A. Training shall include, but not be limited to, procedures and schedules related to performance, safety, startup and shut down, troubleshooting, servicing, preventive maintenance, and how to obtain replacement parts.
1. Access Doors: Adjustment, gasket removal and replacement, handle removal and replacement, and spare parts.
 2. Coils: Cleaning, combing fins, draining, venting, removal, and replacement.
 3. Controls: Calibration, cleaning, operation, service, removal and replacement, and spare parts.
 4. Damper Assemblies: Cleaning, operation, service, removal and replacement, and spare parts.
 5. Drain Pans: Cleaning, removal, and replacement.
 6. Duct Silencers: Cleaning, removal, and replacement.
 7. Fan and Motor Assemblies: Cleaning, operation, removal and replacement, service, and spare parts.
 8. Filters: Operation, removal and replacement, frame gasket removal and replacement, clip removal and replacement, and spare parts.
 9. Humidifiers: Cleaning, operation, service, removal and replacement, and spare parts.
 10. UV-C Lamp Systems: Cleaning, operation, service, removal and replacement, and spare parts.
 11. Lights, Receptacles and Switches: Cleaning, operation, service, removal and replacement, and spare parts.
 12. **<Insert requirement>**.
- B. Instructor:
1. Instructor shall be factory trained and certified by air-handling unit manufacturer with current training on equipment installed.

2. Instructor's credentials shall be submitted for review by **[Architect] [Commissioning Agent] [Owner]** before scheduling training.
 3. Instructor(s) **[primary] [sole]** job responsibility shall be Owner training.
 4. Instructor(s) shall have not less than **[three] <Insert number>** years of training experience with air-handling unit manufacturer and past training experience on at least **[three] <Insert number>** projects of comparable size and complexity.
- C. Schedule and Duration:
1. Schedule training with Owner at least business days before first training session.
 2. Training shall occur before Owner occupancy.
 3. Training shall be held at mutually agreed date and time during normal business hours.
 4. Each training day shall not exceed **[eight] <Insert number>** hours of training. Daily training schedule shall allow time for a **[one] <Insert number>**-hour lunch period and -minute break after every two hours of training.
 5. Perform not less than hours of training.
- D. Location: Owner to provide a suitable on-site location to host classroom training.
- E. Training Attendees: Assume **[three] <Insert number>** people.
- F. Training Attendance Records: For record purposes, document training attendees at start of each new training session. Record date, time, brief description of training covered during the session, attendee's name, signature, phone number, and e-mail address. Submit scanned copy of sign-in sheet to Owner for each training session.
- G. Training Format: Individual training modules to include classroom training followed by hands-on field demonstration and training.
- H. Training Materials: Provide training materials in electronic format to each attendee.
1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
- I. Training Video Recording: Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.
- J. Written Acceptance: Obtain **[Architect] [Commissioning Agent] [or] [Owner]** written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 237343.19

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. LEED Submittals:
 - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: Twoset(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: Five year(s) from date of Substantial Completion.
 - c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
 - 2. Samsung.
 - 3. LG
 - 4. Or equal

2.2 INDOOR UNITS (5 TONS OR LESS)

- a. Condensate pump: Provide integral condensate pump with each indoor unit.
- B. Wall-Mounted, Evaporator-Fan Components:
 - 1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
 - 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
 - 3. Fan: Direct drive, centrifugal.
 - 4. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Totally enclosed, fan cooled.
 - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - f. Mount unit-mounted disconnect switches on exterior of unit.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:
 - a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 1 inch deep.
 - b. Single-wall, stainless-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
7. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 1 inch.
 - 3) Merv according to ASHRAE 52.2: 5.
 - 4) Media: Interlaced glass fibers sprayed with nonflammable adhesive
 - 5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R454B.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
 3. Fan: Aluminum-propeller type, directly connected to motor.
 4. Motor: Permanently lubricated, with integral thermal-overload protection.
 5. Low Ambient Kit: Permits operation down to 45 deg F.
 6. Mounting Base: Polyethylene.

2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls."

- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- E. Drain Hose: For condensate.
- F. Crankcase Heater:
- G. Time Delay Relay; To prevent short-cycling.
- H. Additional Monitoring:
 - 1. Monitor constant and variable motor loads.
 - 2. Monitor variable-frequency-drive operation.
 - 3. Monitor cooling load.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Install seismic restraints.
- E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.

1. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. **Tests and Inspections:**

1. **Leak Test:** After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. **Operational Test:** After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. **Test and adjust controls and safeties.** Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 238216.11 - HYDRONIC AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Hydronic air coils (Energy Recovery).
- B. Related Requirements:
 - 1. Section 238216.13 "Refrigerant Air Coils" for air coils using refrigerants as the medium.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
 - 2. Include rated capacities, operating characteristics, and pressure drops for each air coil.
- B. Sustainable Design Submittals:
 - 1. Product data showing compliance with ASHRAE 62.1.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

- A. Altitude above Mean Sea Level: 500 feet.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."
- B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.

2.2 HYDRONIC AIR COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. RAE Coils; a division of RAE Corporation.
 - 2. Carrier Corporation; a unit of United Technologies Corp.
 - 3. Coil Company, LLC.
 - 4. Colmac Coil Manufacturing, Inc.
 - 5. Greenheck Fan Corporation.

6. Modine Commercial and Industrial Solutions.
 7. Super Radiator Coils.
 8. Trane.
 9. USA Coil & Air.
 10. Or equal
- B. Description: Coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into the coil fins; self-venting; counterflow design of air to fluid.
- C. Tubes:
1. Material: Copper.
 2. Nominal Diameter: Minimum 5/8 inch before expanding, selected to provide performance indicated.
 3. Nominal Wall Thickness: As required by performance, minimum 0.025 inch thick.
 4. Return Bends: 180-degree bends; material[, wall thickness,] and nominal diameter to match tubes.
 5. Fluid Velocity at Design Flow Rate: 3 fps.
 6. Features: [Cleanable] [Individually drainable].
- D. Fins:
1. Type: Waffle.
 2. Materials:
 - a. Aluminum: 0.0080 inch thick.
 3. Spacing: Maximum 10 fins per inch.
 4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
 5. Configuration: Wave-, corrugated-, or waffle-face fins.
 6. Fin and Tube Joint: [Mechanical bond] [or] [silver brazed].
- E. Headers:
1. Material: Copper.
 2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced-header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch.
 3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
 4. Drains: Include low point of supply and return header with a NPS 1/2 (DN 13) drain connection.
 5. Vents: Include high point of supply and return header with a NPS 1/2 (DN 13) vent connection.
 6. Supply and Return Connections: Copper pipe; threaded or flanged, same end of coil.
 7. Protect opening of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into coil.
 8. Fluid Velocity at Design Flow Rate: Maximum of 3 fps.
- F. Casings and Tube Sheets:
1. Depth: Extend coil casing and tube sheets a minimum of 1/2 inch beyond face of fins on both entering and leaving sides.
 2. Materials:
 - a. Stainless steel, Type 304, No. 2D finish, ASTM A240/A240M.
- G. Top and Bottom Casings:
1. Flange face minimum of 1-1/2 inches; double-flange edge for rigidity and ease of removal with secondary flange face minimum of 1/2 inch.
 2. Thickness:
 - a. Coils with Fin Length Exceeding 72 Inches: Minimum of [16 gauge] [14 gauge] [12 gauge] thick.

- H. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.
- I. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 304 stainless steel.
- J. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:
 - 1. Manufacturer name, address, telephone number, and website address.
 - 2. Manufacturer model number.
 - 3. Serial number.
 - 4. Manufacturing date.
 - 5. Coil identification (indicated on Drawings).
 - 6. Coil fin length.
 - 7. Coil fin height.
 - 8. Coil weight with fluid/without fluid.
 - 9. Coil casing material and thickness.
 - 10. Coil fin material and thickness.
 - 11. Coil tube material and thickness.
 - 12. Coil header material and thickness.

2.3 MATERIALS

- A. Aluminum: ASTM B209.
- B. Copper Tube: ASTM B75/ASTM 75M annealed temper or ASTM B280 drawn temper.
- C. Steel:
 - 1. Pipe Connections: ASTM A53/A53M.

2.4 SOURCE QUALITY CONTROL

- A. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than 300-psig internal pressure.
- B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

- C. Install stainless steel drain pan under each cooling coil.
 - 1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
 - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - 3. Extend drain pan upstream and downstream from coil face.
 - 4. Extend drain pan under coil headers and exposed supply piping.
- D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
- E. Straighten bent fins on air coils.
- F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230923.11 "Control Valves," and other piping specialties are specified in Section 232116 "Hydronic Piping Specialties."

END OF SECTION 238216.11

SECTION 238216.13 - REFRIGERANT AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Refrigerant air coils.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
 - 2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.6 FIELD CONDITIONS

- A. Altitude above Mean Sea Level: 150 feet.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."
- B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.
- C. Minimum Working-Pressure/Temperature Ratings: 200 psig/300 deg F.
- D. Select cooling coils for no moisture carryover at design conditions.

2.2 REFRIGERANT AIR COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aerofin.
 - 2. Carrier Corporation; a unit of United Technologies Corp.
 - 3. Coil Company, LLC.

4. Trane.
 5. USA Coil & Air.
- B. Source Limitations: Obtain refrigerant coils from single source from single manufacturer.
- C. Description: Plate fin coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into plate fins. Coils are to be counterflow circuited and equipped with pressure-type distributors, and distributor tubes are to be of equal length, to ensure equal distribution of refrigerant to each circuit.
- D. Circuiting: Face Row Interlaced Interlaced and face control Indicated on Drawings Insert circuiting type.
- E. Tubes:
1. Material: Copper .
 2. Nominal Diameter: Selected for performance indicated.
 3. Nominal Wall Thickness: As required by performance, minimum of 0.025 inch thick.
 4. Return Bends: 180-degree bends; material, , and nominal diameter to match tubes.
 5. Brazing: High-temperature brazing alloy with not less than 5 percent silver.
- F. Fins:
1. Type: Plate.
 2. Materials:
 - a. Copper: 0.0075 inch thick.
 3. Spacing: Maximum 12 fins per inch .
 4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
 5. Configuration: Flat-face fins
 6. Fin and Tube Joint: Silver brazed.
- G. Headers:
1. Material: Seamless copper Insert material.
 2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch.
 3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
 4. Protect openings to prevent entry of dirt into coil.
- H. Casings and Tube Sheets:
1. Depth: Extend coil casing and tube sheets a minimum of 1/2 inch Insert dimension beyond face of fins on both entering and leaving sides.
 2. Materials:
 - a. Stainless steel, Type 304 Insert type, No. 2D finish.
 3. Top and Bottom Casings:
 - a. Flange face minimum of 1-1/2 inches Insert dimension; double-flange edge for rigidity and ease of removal with secondary flange face minimum of 1/2 inch.
 4. End Tube Sheets:
 - a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
 - b. Flange face minimum of 1-1/2 inches Insert dimension.
 - c. Thickness: Minimum of 14 gauge thick.
 5. Intermediate Tube Sheets:

- a. Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
 - b. Space intermediate tube sheets a maximum of 48 inches Insert dimension o.c. and locate to provide equal spacing between tube sheet across coil tube length.
 - c. Flange face minimum of 1/2 inch.
 - d. Thickness: Minimum of 14 gauge thick.
- I. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.
- J. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 316 stainless steel.
- K. Nameplate: stainless steel nameplate with for each coil, with the following data engraved or embossed:
- 1. Manufacturer name, address, telephone number, and website address.
 - 2. Manufacturer model number.
 - 3. Serial number.
 - 4. Manufacturing date.
 - 5. Coil identification (indicated on Drawings).
 - 6. Coil fin length.
 - 7. Coil fin height.
 - 8. Coil weight with fluid/without fluid.
 - 9. Coil casing material and thickness.
 - 10. Coil fin material and thickness.
 - 11. Coil tube material and thickness.
 - 12. Coil header material and thickness.
- L. Coating: None .

2.3 MATERIALS

- A. Copper Tube: ASTM B75/75M annealed temper or ASTM B280 drawn temper.
- B. Stainless Steel: ASTM A240/A240M.

2.4 SOURCE QUALITY CONTROL

- A. Refrigerant Coils: Factory tested using dry nitrogen while coil is completely submerged underwater to design pressure indicated, but not less than 400-psig internal pressure.
- B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Install **stainless steel** drain pan under each cooling coil.
 - 1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
 - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - 3. Extend drain pan upstream and downstream from coil face.
 - 4. Extend drain pan under coil headers and exposed supply piping.
- D. Straighten bent fins on air coils.
- E. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect refrigerant piping according to Section 232300 "Refrigerant Piping."

END OF SECTION 238216.13

SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Ductless fan coil units.
 2. Ducted fan coil units.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 2. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Shop Drawings:
1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Suspended ceiling components.
 2. Structural members to which fan coil units will be attached.
 3. Method of attaching hangers to building structure.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 6. Perimeter moldings.
- B. Seismic Qualification Certificates: For fan coil units, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

- D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Coil Unit Filters: Furnish two spare filters for each filter installed.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

- A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Compressor failure.
 - b. Condenser coil leak.
 - 2. Warranty Period: Five years from date of Substantial Completion.
 - 3. Warranty Period (Compressor Only): Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTLESS FAN COIL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Price
 2. Carrier Global Corporation.
 3. Trane Inc.
 4. Or equal.
- B. Fan Coil Unit Configurations: Row split.
1. Number of Cooling Coils: One with two-pipe system.
- C. Coil Section Insulation:
1. Insulate coil section according to Section 230716 "HVAC Equipment Insulation."
 2. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.
- E. Chassis: Galvanized steel where exposed to moisture, with powder-coat finish and removable access panel.
- F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.
- G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
1. MERV Rating: 8 when tested according to ASHRAE 52.2.
- H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- I. Fan and Motor Board: Removable.
1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
- J. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
- K. Terminal Controller: DDC.
1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
 2. Unoccupied-Period-Override Operation: Two hours.
 3. Unit Supply-Air Fan Operation:
 - a. Occupied Periods: Fan runs continuously.
 - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

4. Hydronic-Cooling-Coil Operation:
 - a. Occupied Periods: Modulate control valve to maintain room temperature.
 - b. Unoccupied Periods: Close control valve.
5. Controller shall have volatile-memory backup.
- L. Interface with DDC System for HVAC Requirements:
 1. Interface relay for scheduled operation.
 2. Interface relay to provide indication of fault at the central workstation.
 3. Provide BACnet interface for central DDC system for HVAC workstation for the following functions:
 - a. Adjust set points.
 - b. Fan coil unit start, stop, and operating status.
 - c. Data inquiry, including supply- and room-air temperature.
 - d. Occupied and unoccupied schedules.
- M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.3 DUCTED FAN COIL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Price
 2. Carrier Global Corporation.
 3. Trane Inc.
 4. Or equal.
- B. Fan Coil Unit Configurations: Row split.
 1. Number of Cooling Coils: One with two-pipe system.
- C. Coil Section Insulation:
 1. Insulate coil section according to Section 230716 "HVAC Equipment Insulation."
 2. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- E. Chassis: Galvanized steel where exposed to moisture, with powder-coat finish and removable access panel.
- F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
 1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis with mill-finish, aluminum, double-deflection grille.
 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
 3. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
- H. MERV Rating: 8 when tested according to ASHRAE 52.2.

- I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- J. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
 - 1. Motors: Comply with requirements in Section 230500 "Common Work Results for HVAC."
- K. Control devices and operational sequence are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- L. Terminal Controller: DDC
 - 1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
 - 2. Unoccupied-Period-Override Operation: Two hours.
 - 3. Unit Supply-Air Fan Operation:
 - a. Occupied Periods: Fan runs continuously.
 - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
 - 4. Hydronic-Cooling-Coil Operation:
 - a. Occupied Periods: Modulate control valve to maintain room temperature.
 - b. Unoccupied Periods: Close control valve.
 - 5. Controller shall have volatile-memory backup.
- M. Interface with DDC System for HVAC Requirements:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation.
 - 3. Provide BACnet interface for central DDC system for HVAC workstation for the following functions:
 - a. Adjust set points.
 - b. Fan coil unit start, stop, and operating status.
 - c. Data inquiry, including supply- and room-air temperature.
 - d. Occupied and unoccupied schedules.
- N. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FAN COIL UNITS

- A. Install fan coil units level and plumb.

- B. Install fan coil units to comply with NFPA 90A.
- C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.
- B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

END OF SECTION 238219

SECTION 260400 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Design Intent:
1. The Contract Documents indicate and specify the electrical design intent. The Contract Drawings are schematic and diagrammatic and are not intended to indicate construction details and routing unless specifically indicated. The specifications establish minimum performance, product and installation requirements.
 2. In addition to the specified and indicated performance and quality requirements, furnish products and perform installation work consistent with the design intent, industry standards and as necessary to the provision of complete operating electrical systems.
 3. Install electrical work in accordance with the National Electrical Code and all applicable local codes in a neat and workmanlike manner.
 4. This Section specifies basic electrical requirements applicable to all Divisions unless explicitly excepted.
 5. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
 6. Contractor shall thoroughly review entire set of Contract Documents, including all discipline drawings and specifications prior to bidding and include all required electrical work in bid, even if not explicitly shown on electrical Drawings and Specifications.

1.2 REFERENCES

- A. American National Standards Institute (ANSI) C2 - National Electrical Safety Code.
- B. City of **Livermore** Ordinances.
- C. State of **California** Codes.
- D. National Electrical Contractors Association (NECA).
1. 1 - Standard for Good Workmanship in Electrical Construction.
 2. 500 - Recommended Practice for Installing Indoor Commercial Lighting Systems.
- E. National Fire Protection Association (NFPA).
1. 70 - National Electrical Code (NEC).
 2. 70E - Standard for Electrical Safety in the Workplace.
 3. 72 - National Fire Alarm and Signaling Code.
 4. 101 - Life Safety Code.
 5. 111 - Standard for Stored Electrical Energy Emergency and Standby Power Systems.

1.3 Submittals

- A. General
1. Submit Shop Drawings, Product Data, Samples and other specified submittals on a "system" basis. Retain, and assemble drawings and data from manufacturer or component manufacturers such that each submittal is for a complete system.
 2. Refer to Section 013300, "Shop Drawings, Product Data and Samples", for basic definitions and requirements for submittals.

3. Refer to Section 013330 for submittal compliance form.
- B. Quality Control Submittals
1. Submit results of factory tests two weeks prior to product shipment from factory.
 2. Submit results of field tests immediately upon completion of the field test.
- C. Contract Closeout Submittals
1. Refer to Division 01, "Record Documents", for basic definitions and requirements for record documents.
 2. Submit, at the completion of the work, record drawings per Division 01 and in an approved electronic format matching the electronic format in which the construction documents were produced. Indicate the actual electrical installation, size and construction details. Include the following information:
 - a. Lighting layout, type, circuit designation and control, including each conduit and wire as installed.
 - b. Power distribution system, including distribution equipment and each conduit and wire size installed.
 - c. Layout and circuiting for wiring devices, surface raceways and related equipment, including location of all outlets, junction boxes, and conduit runs, including conduit size, circuit numbers, and number of wires in each run.
 - d. Layout and circuitry for power circuits to mechanical equipment and other electrified building equipment, including each conduit and wire size.
 - e. Panel schedule drawings consisting of each panelboard. Schedules shall indicate the • • as built • • circuiting with loads and room numbers identified. Room numbers on schedules shall include the architectural room number indicated on the Drawings and the signage room numbers from the signage schedules. Each circuit in the panel schedules shall be uniquely identified, regardless of how they are indicated on the construction documents.
 - f. Layout and location of above ceiling devices, including, but not limited to, controllers, control panels, emergency load transfer devices, power supplies, relays, battery packs and all other electrical equipment and products requiring maintenance, service, adjustment or replacement in the future.

1.4 PROJECT/SITE CONDITIONS

- A. Environmental Requirements
1. Provide products suitable for operation under the following environmental conditions:
 - a. Temperature: -18 to 38 degrees C (0 to 100 degrees F).
 - b. Humidity: 0 to 95 relative percent, non-condensing.
 - c. Altitude: 2010 meters (6600 feet) above sea level.
 - d. Outdoor: Products that are UL listed for wet locations.

1.5 WARRANTIES

- A. Refer to the Conditions of the Contract for provisions concerning Contract general warranty, Statements of Compliance, correction of Work period, and form of Special Warranty.
- B. All electrical systems, equipment and installations shall be provided with a one-year minimum Warranty starting from the date of substantial completion.

- C. During the warranty period, and for non-conformities the contractor shall take all necessary and appropriate action; free of charge, to correct any non-conformity with the warranties contained in the manufacturer agreement. During the warranty period, contractor shall provide to Owner, free of costs and charges, all support necessary to ensure that the installation meets the requirements specified in the Contract Documents and performance guarantees provided by the contractors. During the warranty period, contractors shall furnish, or cause to be furnished, all maintenance, service, parts and replacements necessary to maintain the installation in good working condition, at no cost to Owner.

1.6 CONDUCTOR SIZING

- A. Feeder and Branch Circuit Sizing
 - 1. Provide feeder and branch circuits per the circuit sizing schedules indicated on Drawings. Where schedules are not indicated, provide conductors which are sized as required per the NEC for the indicated overcurrent protective device rating. Circuit sizing and installation shall consider the field routing and anticipated voltage drop. Upsize wire, as necessary, to compensate for voltage drop and/or other forms of derating required in accordance with the NEC.
 - 2. Derate conductor ampacities per the NEC for field conditions including but not limited to conduits exposed to sunlight, elevated ambient temperature, and/or more than 3 current carrying conductors in a raceway.

1.7 SYSTEMS INTEGRATION

- A. Coordinate with equipment suppliers and ensure integration of systems comprised of disparate equipment which work together to form a complete system.
- B. Provide all miscellaneous components, wiring, hardware, etc. required for complete and operational equipment and systems whether or not these items are explicitly shown in the Contract Documents.
- C. Provide systems which maintain the UL rating of the individual pieces of equipment.
- D. Submit system integration wiring diagrams, control diagrams and sequence of operation, as needed.

1.8 COORDINATION

- A. Contractor shall participate in the project scheduling, coordination meetings and coordination drawing/modeling activities as specified in Division 01.
- B. All potential coordination issues shall be brought to the attention of the Construction Manager immediately before proceeding with the installation.
- C. Contractor shall be responsible for all cross connecting and coordination with vendors and other trade contractors to provide complete operational systems.
- D. For purpose of clarify and legibility, drawings are diagrammatic. Locate equipment as close as practical to the locations shown on the drawings. Should field conditions prevent the installation of equipment or materials as indicated on the drawings, make deviations only with the prior approval of the Owner's representative.
- E. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping at required slope.
 - 4. To allow connecting raceways, cables, wireways, cable trays, and busways to be clear of obstructions and of the working and access space of other equipment.

- F. Coordinate work with other trades to ensure completion is consistent with the project schedule. Ensure the NEC-required working space and dedicated electrical space about electrical equipment is provided. Foreign systems shall not be located within these dedicated zones. Any work that encroaches on the working space or dedicated electrical space shall be relocated at the Contractor's expense.
- G. Equipment and device mounting heights and alignment shall adhere to architectural drawings, rules and requirements. Devices of all trades within the same general area shall be coordinated prior to construction. Care shall be taken to align devices horizontally and vertically. Devices that are not aligned properly shall be relocated at the Contractor's expense.
- H. Coordinate exact conduit routing in the field with other trades and with building elements such as structural steel members. Conduit and raceways are not explicitly shown. Conduit routing where shown on drawings shall be considered approximate. Contractor shall be responsible for final routing in the field and shall be responsible for complete coordination with all other trades.
- I. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- J. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8.
- K. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

PART 2 - PRODUCTS

2.1 Manufacturers

- A. General
 - 1. Furnish products by one of the equipment manufacturers listed under the heading "Manufacturers" within the applicable sections. When given, furnish the specified product model or brand for the selected manufacturer.
 - 2. Provide products, for which quantities of two or more are to be furnished, from the same manufacturer and of the same product or model series.
 - 3. Furnish product components designed to be used together and which are physically and electrically compatible.
- B. Comparable Products
 - 1. Comparable products may be proposed when the "or as approved" clause is specified under the heading "Manufacturers". Submit such products substitutions for approval per Division 01, "Product Requirements."
- C. Product Substitutions
 - 1. Product substitutions may be requested under the conditions specified in Division 1 "Substitution Procedures". Submit product substitutions for consideration per Division 01, "Substitution Procedures".

2.2 Products

- A. Product Listing and Labeling
 - 1. Provide listed and labeled product for which listings and labels exist by Underwriters Laboratories Inc. (UL), Factory Mutual (FM), or similar independent testing organizations recognized by the authorities having jurisdiction. For products for which there are no such listings and labels, provide listed and labeled components of those products, for which component listing and labels exist.

- B. PCB Content Prohibited
 - 1. Provide products which do not contain any amounts of polychlorinated biphenyl (PCB) compounds.
- C. Asbestos Content Prohibited
 - 1. Provide products which do not contain any amounts of asbestos.
- D. Access Doors
 - 1. Provide access doors necessary to access devices, whether for control or maintenance, governed by these Basic Electrical Materials and Methods. Comply with access door requirements specified in Division 08. Access doors are not explicitly shown on the Drawings.
 - 2. Access doors shall be coordinated with other trades and final locations shall be approved by Architect. Access doors not approved by Architect shall be removed or relocated at the Contractors expense.
 - 3. Access doors installed in fire rated floors, walls or ceilings shall be sufficiently rated to maintain the rating of the surface where installed.

2.3 Source Quality Control

- A. Factory Tests
 - 1. Permit Architect and Owner to observe factory tests. Provide minimum five working days notice of factory tests.
 - 2. Schedule no more than one equipment or system factory test per week.

PART 3 - EXECUTION

3.1 SHUTDOWNS

- A. Interruption of Existing Service: Do not interrupt electric, communications or fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of service.
 - 2. Indicate method of providing temporary service.
 - 3. Do not proceed with interruption of service without Architect's, Construction Manager's and Owner's written permission.
 - 4. Comply with NFPA 70E.
- B. Coordinate all service interruptions with other disciplines and Owner's representative. Shutdowns shall be performed during off hours, which may include weekends or holidays. This premium time cost shall be included in the Contractor's base bid.
- C. Maintain Owner communications and network services operations during construction. Coordinate all service interruptions with other disciplines and Owner's representative.
- D. Maintain Owner fire alarm systems and services operations during construction. Coordinate all service interruptions with other disciplines and Owner's representative.

3.2 DEMOLITION

- A. Protect adjacent building services and materials indicated to remain. Install and maintain barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition is complete.

- B. "Carefully remove, clean and restore and reinstall items that are relocated during construction to a "like new" condition.
- C. Building elements such as walls, partitions, floors and ceilings affected by electrical construction such as conduit penetrations shall be repaired, patched, painted and otherwise restored to a "like new" condition.
- D. Lamp and Ballast Recycling.
 - 1. Recycle lamps, ballasts and drivers containing hazardous materials such as mercury during construction. These shall include tubular fluorescent, compact fluorescent, HID, LED, induction and cold cathode lamps. These lamp types, ballasts and drivers associated with these lamps shall not be disposed of as solid municipal waste.
- E. Equipment Protection and Cleanup.
 - 1. Protect equipment and materials during shipment, storage and construction against damage, dust and contamination. Items that become damaged, dirty or contaminated during construction shall be restored to a "like new" condition or replaced at the Contractor's expense.
 - 2. Remove and legally dispose of demolished items, rubbish, debris and construction waste from the construction site daily, and at the completion of the work. The contractor shall maintain a "clean" work site. Failure to do so may result in the cleanup being performed by others and all costs thereof being deducted from the Contractor's final payment.

3.3 TEMPORARY SERVICE

- A. The facility will remain operational during construction. Provide equipment, hardware, wiring, etc. to maintain systems scheduled to remain operational during construction. Coordinate detailed work phasing plans with the Construction Manager, Architect and Owner prior to commencing work.
- B. Provide, maintain and remove all temporary lighting, power and communications required to complete the project.
 - 1. Coordinate temporary service installation with the local utility companies and building landlord prior to construction.
- C. In addition to NEC ground fault protection requirements, provide ground fault protection on temporary feeders 200 amps and greater.
- D. Temporary feeders shall be limited to the following types:
 - 1. Conductors installed in raceways.
 - 2. Type MC cable.
 - 3. Multi-conductor cable with an overall protective outer jacket (where inaccessible to the public and not subject to physical damage or abuse).
 - 4. NEC recognized hard usage cord (where inaccessible to the public and not subject to physical damage or abuse).
 - 5. Label temporary feeders every 25 feet maximum

3.4 INSTALLATION

- A. General
 - 1. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless otherwise indicated.
 - 2. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

3. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
 4. Right of Way: Give to piping systems installed at a required slope.
- B. Wiring Installation
1. Install wiring for control systems, power feeder and branch circuits, lighting branch circuits, communication and auxiliary systems, such as fire alarm and security, in separate raceways unless otherwise indicated.
 2. Install power system wiring for "Life Safety," "Legally Required Standby," and "Optional Standby," systems in separate raceways.
 3. Prior to rough-in of electrical and telecommunications devices, verify locations with the owner's final furniture plans and the system supplier's approved installation drawings. Adjust locations of devices to coordinate with furniture and equipment layouts.
- C. Device Location
1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, occupancy sensors, fire alarm devices and access control devices, within a 10-foot radius of indicated location without additional cost.
 2. Refer to architectural plans for device location, mounting and alignment rules and requirements. Coordinate all device and lighting fixture placement with other trades prior to rough-in.
 3. Devices in proximity to each other shall be horizontally and vertically aligned. Devices which are not aligned properly shall be relocated as required to meet alignment requirements at no cost to Owner.
 4. Coordinate device placement and installation with other trades **[and Architect/Engineer]** prior to construction and rough-in.
- D. NECA Compliance
1. Install products in accordance with applicable NECA Standards, unless otherwise specified or indicated.
- E. Wet, Damp, or Dry Location Work
1. Provide products as appropriate for wet, damp, or dry locations as defined by NFPA 70.
- F. Manufacturer Installation Instructions
1. Install equipment in accordance with the manufacturer's installation instructions and recommendations.
- G. Fire and Smoke Barrier Penetrations
1. Install firestopping to raceways, boxes and electrical equipment installed in or penetrating fire-rated floor and wall assemblies and smoke barrier assemblies, in a manner which maintains the fire resistance rating or barrier intent.
- H. Field Painting
1. Refer to Division 09 for prime and finish field painting requirements.
 2. Field paint electrical equipment, products, materials, components and systems where indicated.
 3. In a manner approved by the manufacturer and satisfactory to the Owner, touch-up or refinish factory-applied paints or finishes which are chipped, defaced, scratched, or in any other way disturbed due to handling, installation, or general construction work.
- I. Exposed Construction
1. Take care in areas where the installation is exposed and visible to the public. Install electrical systems and equipment in an organized fashion and field painted. Mounting surfaces shall be repaired, patched, and painted to provide a "like new" appearance.

2. Coordinate systems (e.g. conduit, cable tray, wiring, duct work, piping, hanger, supports, etc.) prior to installation.

J. Personnel Protection from Suspended Work

1. Where suspended equipment, piping or ductwork or any of their supporting or reinforcing members extend 2.1 meters (7 feet) or less above the floor or any other walking surface, cover all edges, projecting surfaces and sharp corners with pre-fabricated soft rubber pads, elastomeric insulation, caps or equivalent to prevent injury to personnel.

K. Feeder and Branch Circuit Sizing

1. Provide feeder and branch circuit sizing per schedules indicated on drawings.

3.5 ACCEPTANCE TESTING

A. General.

1. Provide necessary test equipment and be responsible for setting-up test equipment, wire checks of factory wiring and any other preliminary work in preparation for the electrical acceptance tests.
2. Perform tests which do not exceed the manufacturer's recommended limit for the equipment being tested.
3. Where required for the validity of tests or safety of equipment and personnel, isolate equipment to be tested from the system.
4. Include the ambient temperature and relative humidity existing at the time when performing insulation resistance, dielectric absorption or high potential tests.
5. Coordinate testing and inspections with commissioning agent.

B. Visual Inspections.

1. Prior to any testing, perform visual inspections to verify the following:
 - a. The equipment is completely and properly installed.
 - b. The equipment is free from damage and defects.
 - c. Shipping blocks and restraints have been removed.
 - d. Electrical terminations are properly tightened.
 - e. The equipment is properly aligned.
 - f. The equipment is properly lubricated.
 - g. The ventilation louvers are open and unobstructed.
 - h. The equipment is ready to be tested.

C. Manual Operation.

1. Prior to any testing, operate mechanical devices to verify that they function properly and freely.

D. Insulation Resistance Test.

1. Perform test with a voltage source capable of providing a constant direct voltage for the time intervals as specified below.
 - a. 150 volts and under - 500 volts.
 - b. 151-600 volts - 1000 volts.
 - c. Hold 1000-volt and 500-volt insulation resistance tests for a minimum of one minute or until the reading reaches a constant value for 15 seconds unless specified otherwise.
 - d. Apply tests from phase to ground with the other phases grounded. Test each phase in a similar manner.
 - e. Check phase matching and phase identification immediately prior to energizing equipment.

E. Fire Alarm System Test.

1. Fire alarm and smoke detector systems shall be tested by operating each pull station and activating all system sensors to verify proper operation.
2. Voice communications systems shall be tested to verify correct operation of all voice inputs and all speakers.

3.6 Field Quality Control

- A. Field Tests
 1. Permit Architect and Owner to observe field tests. Provide minimum [three][five]working days notice of field test.
 2. Schedule tests in coordination with other Contract work. Schedule no more than one equipment or system field test per day.
 3. Provide test reports.
- B. Inspect installed sleeves and firestopping for damage or faulty work. Replace defective installations.
- C. Replace any equipment, system or materials found to be defective or found to be of lesser quality than that specified or shown on the Drawings.

3.7 CLEANING

- A. Clean electrical equipment and systems to remove dirt, paint or other foreign materials and restore to match original condition and finish upon completion of construction.

3.8 TRAINING

- A. General
 1. Provide training for Owner's personnel in the operation and maintenance of equipment as specified in the applicable Section for the particular equipment and system.
 2. Develop training schedule which is acceptable to the Owner. Submit schedule for approval.
 3. Provide instruction books, manuals, and other classroom material required as part of the training sessions.
 4. Provide instructors who are certified by the equipment and system manufacturers.
 5. Provide training for a minimum of three of the Owner's personnel, or as specified in the applicable Section.
 6. Conduct training at Project Site after the equipment/system has been installed.
- B. Operations and Maintenance Training
 1. Train personnel in all aspects of normal operation of the equipment, including starting, adjustments while running, and shutdown.
 - a. Train personnel to recognize incipient problems, including inefficient or dangerous modes of operation, and provide instruction in corrective actions to be taken.
 2. Train personnel to perform all recommended maintenance on the equipment.

END OF SECTION

SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.2 DEFINITIONS

- A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
- B. NETA ATS: Acceptance Testing Specification.
- C. Sheath: A continuous metallic covering for conductors or cables.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Design Data: Cable pulling calculations, including conduit size and fill percentage, pulling tensions, cable sidewall pressure, jam probability, voltage drop, and ground wire sizing for each cable.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Test and inspect cables according to ICEA S-93-639 before shipping.
- B. Test strand-filled cables for water penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.
- C. Cables shall be shipped with moisture-proof end seals on conductors. Cable seals shall be rubber or plastic caps.
- D. Each cable reel shall be tagged with the following:
 - 1. Manufacturer, date manufactured, and reel number
 - 2. Cable size, type, and length
 - 3. Voltage Class, and tolerances
 - 4. Customer name, order number, and job name.
- E. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable. Installer must be approved in writing by Facilities Engineering.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2 and NFPA 70.
- C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Okonite Company (The) "Okoguard-Okoseal", cable type "Uniblend".
- B. Cable Type: Type MV-105.
- C. Conductor Insulation: Ethylene-propylene rubber.
 - 1. Voltage Rating: 25 kV.
 - 2. Insulation Thickness: 133 percent insulation level.
- D. Conductor: Copper.
- E. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.
- F. Conductor Stranding: Compact round, concentric lay, Class B.
- G. Strand Filling: Conductor interstices are filled with impermeable compound.
- H. Lead Content: Less than 300 parts per million.
- I. Shielding: Copper tape, helically applied over semiconducting insulation shield.
- J. Cable Assembly: Single-conductor.
- K. Cable Jacket: Sunlight-resistant PVC.

2.3 CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M.
 - 2. Cooper Power Systems, an Eaton business.
 - 3. Engineered Products Company.
 - 4. G&W Electric Company.
 - 5. Scott Fetzer Co. (The).
 - 6. Thomas & Betts Corporation; A Member of the ABB Group.
- B. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.
- C. Copper-Conductor Connectors: Copper barrel crimped or Aluminum barrel crimped connectors.

2.4 SOLID TERMINATIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
 2. Cooper Power Systems, an Eaton business.
 3. Engineered Products Company.
 4. G&W Electric Company.
 5. Scott Fetzer Co. (The).
 6. Thomas & Betts Corporation; A Member of the ABB Group.
- B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.
 2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
 4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
 5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape; cold-shrink-rubber sleeve; or heat-shrink, plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
 6. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
1. 3M.
 2. Cooper Power Systems, an Eaton business.
 3. Engineered Products Company.
 4. G&W Electric Company.
 5. Scott Fetzer Co. (The).
 6. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
- D. Dead-Break Cable Terminators: Elbow-type unit with 200 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.

3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
- F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

2.6 MEDIUM-VOLTAGE TAPES

- A. Description: Electrical grade, insulating tape rated for medium voltage application.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
 2. Cooper Power Systems, an Eaton business.
 3. Engineered Products Company.
 4. G&W Electric Company.
 5. Scott Fetzer Co. (The).
 6. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.
- D. Silicone rubber-based, 12-mil self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches wide.

2.7 ARC-PROOFING MATERIALS

- A. Description: Fire retardant, providing arc flash protection.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
 2. Cooper Power Systems, an Eaton business.
 3. Engineered Products Company.
 4. G&W Electric Company.
 5. Scott Fetzer Co. (The).
 6. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- D. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.
- E. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 before shipping.
- B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.
 - 1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
 - 2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 - 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
 - 4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- G. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- H. Install cable splices at pull points and elsewhere as indicated; use standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.
- I. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.
- J. Install separable insulated-connector components as follows:
 - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - 2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
 - 3. Standoff Insulator: At each terminal junction, with one on each terminal.
- K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
 - 1. Clean cable sheath.
 - 2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
 - 3. Smooth surface contours with electrical insulation putty.
 - 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.

5. Band arc-proofing tape with two layers of 1-inch- wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.
- L. Terminations:
 1. All terminations shall be accomplished via pre-molded EPDM type connection system. The 600 amp separable insulated connector system shall be rated for continuous operation at 15kV for single conductor shielded power cables and shall be non-load / dead break type.
 2. The system shall be made up of specific kits (600 amp) designed for tapping, dead-ending, and connecting equipment. Dead-break cable terminators shall be elbow type with 600 amp continuous current rating.
 3. The system shall accommodate a 15kV cable size of 250 MCM, copper conductors, unless larger sizes are indicated on Drawings. The system shall be capable of making dead-end, 2-way and multiple tap splices and shall be suitable for continuous immersion under water.
 4. Conductor terminations may be cold or heat shrink type termination kits rated 15kV, 95kV BIL with current rating same as the cable. Splice kits are not acceptable.
- M. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."
- N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- O. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.
- P. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.
 1. Raceway Tags:
 - a. Manufacturers: Subject to compliance with the requirements, provide products by the following or an equivalent product by an alternate manufacturer:
 - 1) Tech Products Inc. - Fast Tag Miniature Markers
 - b. Characteristics:
 - 1) Provide tags with highly-raised characters, hot stamped with UV stable foil, non-conductive and non-corroding.
 - 2) Tags shall be black lettering on yellow background.
 - 3) Attach tags to raceways with noncorrosive stainless steel wire.
 - 4) Tags shall be provided at minimum where the cable enters and leaves the manhole.
 - c. Labeling Verbiage:
 - 1) Where the cable enters the manhole:
 - a) Line 1: 'Voltage' - CKT 'X'
 - b) Line 2: From MH-'X'
 - c) Example: 4800V - CKT A, From MH-5
 - 2) Where the cable leaves the manhole:
 - a) Line 1: 'Voltage' - CKT 'X'
 - b) Line 2: To MH-'X' or 'Building'
 - c) Example 1: 4800V - CKT A, To MH-200
 - d) Example 2: 4800V - CKT A, To NML

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

- B. Perform the following tests and inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform electrical tests on each new conductor according to NETA ATS, Ch 7.3.3. Use Very Low Frequency (VLF) testing where options exist.
- C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 260513

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Standards:
 - 1. Products listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide"

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alpha Wire Company.
 - 2. American Bare Conductor.
 - 3. Belden Inc.
 - 4. Cerro Wire LLC.
 - 5. Encore Wire Corporation.
 - 6. General Cable Technologies Corporation.
 - 7. Okonite Company (The).
 - 8. Service Wire Co.
 - 9. Southwire Company.
 - 10. WESCO.
- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 and ASTM B 496 for stranded conductors.
- D. Conductor Insulation:
 - 1. Refer to Part 3 for conductor insulation application. Comply with UL Standard appropriate for cable insulation.

2.2 ALUMINUM BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alpha Wire Company.
 - 2. American Bare Conductor.
 - 3. Belden Inc.
 - 4. Cerro Wire LLC.
 - 5. Encore Wire Corporation.
 - 6. General Cable Technologies Corporation.
 - 7. Okonite Company (The).
 - 8. Southwire Company.
 - 9. WESCO.
- C. Conductors: Aluminum, complying with ASTM B 800 and ASTM B 801.
- D. Conductor Insulation:
 - 1. Type XHHW-2: Comply with UL 44.

2.3 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems Inc.
 - 2. Alpha Wire Company.
 - 3. American Bare Conductor.
 - 4. Belden Inc.
 - 5. Encore Wire Corporation.
 - 6. General Cable Technologies Corporation.
 - 7. Okonite Company (The).
 - 8. Service Wire Co.
 - 9. Southwire Company.
 - 10. WESCO.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1569.
- D. Circuits:
 - 1. Single circuit or multicircuit (3-circuit, maximum) with color-coded conductors.
 - 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- E. Conductors: [Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors] [Aluminum, complying with ASTM B 800 and ASTM B 801].
- F. Ground Conductor: Insulated.
- G. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2: Comply with UL 83.

2. Type XHHW-2: Comply with UL 44.

H. Armor: Steel, interlocked.

2.4 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. 3M Electrical Products.
 2. AFC Cable Systems; a part of Atkore International.
 3. Gardner Bender.
 4. Hubbell Power Systems, Inc.
 5. Ideal Industries, Inc.
 6. ILSCO.
 7. NSi Industries LLC.
 8. O-Z/Gedney; a brand of Emerson Industrial Automation.
 9. Service Wire Co.
 10. TE Connectivity Ltd.
 11. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 1. Material: Bronze or matching conductor material.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- E. PV Circuits: **Copper**. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- F. Isolated Power System Secondary Conductor Type: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway .
- B. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC .

- C. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2 or XHHW-2, single conductors in raceway .
- D. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway; Metal-clad cable, Type MC - allowable where panel and branch circuits reside in same room; homerun shall be in conduit only.
- E. Feeders and Branch Circuits Installed on Rooftops: Type XHHW-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.
- H. Install cable per manufacturer's recommendations.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material **and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.**
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- D. Cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:

1.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency and testing agency's field supervisor.
- B. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

- A. +Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1) Test wells.
 - 2) Ground rods.
 - 3) Ground rings.
 - 4) Grounding arrangements and connections for separately derived systems.
 - b. Instructions for periodic testing and inspection of grounding features at test wells, ground rings and grounding connections for separately derived systems based on NETA MTS.
 - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.

2. ERICO International Corporation.
3. Galvan Industries, Inc.; Electrical Products Division, LLC.
4. ILSCO.
5. O-Z/Gedney; a brand of Emerson Industrial Automation.
6. Robbins Lightning, Inc.
7. Siemens Power Transmission & Distribution, Inc.
8. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Bonding Conductor: No. 6 AWG, minimum, stranded conductor.
 4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, [1/4 by 4 inches] in cross section, with 9/32-inch holes spaced 1-1/8 inches apart, unless otherwise indicated or specified. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.
- D. Lead Content: Less than 300 parts per million.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- J. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- K. Water Pipe Clamps:
 1. Mechanical type, two pieces with zinc-plated or stainless-steel bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad; 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Underground Grounding Conductors: Install bare copper conductor, **No. 2/0** AWG minimum.
 1. Bury at least 24 inches below grade.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- C. Conductor Terminations and Connections:
 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Ground separately-derived ac power system neutrals, including distribution transformers, to the grounding electrode system per NFPA 70.
- B. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- G. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 24 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. Use exothermic welds for all below-grade connections.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of **building**.
1. Install tinned-copper conductor not less than **No. 2/0** AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches from building's foundation.
- J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than **No. 4** AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
- L. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- F. Grounding system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 - 5. Substations and Pad-Mounted Equipment: 5 ohms.
 - 6. Manhole Grounds: 10 ohms.
- I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Steel slotted support systems.
 2. Aluminum slotted support systems.
 3. Nonmetallic slotted support systems.
 4. Conduit and cable support devices.
 5. Support for conductors in vertical conduit.
 6. Structural steel for fabricated supports and restraints.
 7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
 8. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
1. Hangers. Include product data for components.
 2. Slotted support systems.
 3. Equipment supports.
 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for electrical systems.
1. Include design calculations and details of hangers.
 2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
 2. Ductwork, piping, fittings, and supports.
 3. Structural members to which hangers and supports will be attached.

4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.
- B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M.
 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE 7 Section 13.3 as defined in ASCE 7 Sections 13.6.5, 13.6.6, 13.6.7, and 13.6.8; and 2022 CBC, Sections 1617A1.24, 1617A.1.25 and 1617.1.26
1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
 2. Component Importance Factor: 1.0.
 3. .
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Allied Tube & Conduit; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. ERICO International Corporation.
 - d. Flex-Strut Inc..
 - e. GS Metals Corp.
 - f. G-Strut.
 - g. Haydon Corporation.
 - h. Metal Ties Innovation.
 - i. Thomas & Betts Corporation; A Member of the ABB Group.
 - j. Unistrut; Part of Atkore International.
 - k. Wesanco, Inc.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Stainless steel, Type 304.
 4. Channel Width: 1-5/8 inches 1-1/4 inches 13/16 inches.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA 101
 3. NECA 102.
 4. NECA 105.
 5. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as **scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70**. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted **or other** support system, sized so capacity can be increased by at least **25** percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with **two-bolt conduit clamps**. Refer to support details in the ES drawing series.

- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, **EMT, IMC and RMC** may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: **Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, refer to ES drawing series.**
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate **by means that comply with seismic-restraint strength and anchorage requirements.**
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in **Section 033000 "Cast-in-Place Concrete."**
- C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in **Section 099113 "Exterior Painting"**, **Section 099123 "Interior Painting"** and **Section 099600 "High-Performance Coatings"** for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Metal conduits and fittings.
 2. Nonmetallic conduits and fittings.
 3. Metal wireways and auxiliary gutters.
 4. Surface raceways.
 5. Boxes, enclosures, and cabinets.

1.2 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems; a part of Atkore International.
 - b. Allied Tube & Conduit; a part of Atkore International.
 - c. Anamet Electrical, Inc.
 - d. Calconduit.
 - e. Electri-Flex Company.
 - f. FSR Inc.
 - g. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - h. Republic Conduit.
 - i. Southwire Company.
 - j. Thomas & Betts Corporation; A Member of the ABB Group.
 - k. Topaz Electric; a division of Topaz Lighting Corp.
 - l. Western Tube and Conduit Corporation.
 - m. Wheatland Tube Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: As specified above.
2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew or compression.
6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

- C. Joint Compound for IMC, GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems; a part of Atkore International.
 - b. Anamet Electrical, Inc.
 - c. Arco Corporation.
 - d. CANTEX INC.
 - e. CertainTeed Corporation.
 - f. Electri-Flex Company.
 - g. Kraloy.
 - h. RACO; Hubbell.
 - i. Thomas & Betts Corporation; A Member of the ABB Group.
 - j. Topaz Electric; a division of Topaz Lighting Corp.
2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. Continuous HDPE: Comply with UL 651A.
8. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:

1. Manufacturers: As specified above.
2. Fittings, General: Listed and labeled for type of conduit, location, and use.

3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - a. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. B-line, an Eaton business.
 2. Hoffman; a brand of Pentair Equipment Protection.
 3. MonoSystems, Inc.
 4. SquareD.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. MonoSystems, Inc.
 - c. Panduit Corp.
 - d. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Adalet.
 2. Crouse-Hinds, an Eaton business.
 3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. FSR Inc.
 6. Hoffman; a brand of Pentair Equipment Protection.
 7. Hubbell Incorporated.
 8. Hubbell Incorporated; Wiring Device-Kellems.
 9. Kraloy.
 10. O-Z/Gedney; a brand of Emerson Industrial Automation.
 11. RACO; Hubbell.
 12. Spring City Electrical Manufacturing Company.
 13. Thomas & Betts Corporation; A Member of the ABB Group.

14. Topaz Electric; a division of Topaz Lighting Corp.
 15. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are allowed.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVCdirect buried or concrete encased as indicated.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed and Subject to Physical Damage: GRC. Raceway locations include the following:
 - a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - b. Mechanical rooms.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 5. Damp or Wet Locations: GRC.
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size for indoors and 1-inch trade size for outdoors.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- I. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- J. Support conduit within 12 inches of enclosures to which attached.
- K. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- L. Stub-Ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.

3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

X. Expansion-Joint Fittings:

1. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

CC. Locate boxes so that cover or plate will not span different building finishes.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

- b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
- 5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260539 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Flat-top, single- or multichannel, underfloor raceways.
 2. Flush, flat-top underfloor raceways.
 3. Cellular metal underfloor raceways.
 4. Trench-type underfloor raceways.
 5. Supports, raceway fittings, and hardware.
 6. Junction boxes.
 7. Service fittings.

1.2 ACTION SUBMITTALS

- A. Product Data: For underfloor raceway components, fittings, and accessories.
- B. Shop Drawings: For underfloor raceways.
1. Include floor plans, elevations, sections, and details.
 2. Identify components and accessories, such as expansion-joint assemblies, straight raceway lengths, preset and afterset inserts, and service fittings.
 3. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
 4. Provide raceway fill charts for each duct size provided for each conductor size the duct is identified to accept.
 5. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements, including slab reinforcement, floor finish work, permanent partitions, expansion joints, **architectural module lines**[], and **pretensioning or post-tensioning components**.
 6. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
 7. Indicate thickening of slabs where required for adequate encasement of raceway components.
 8. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
 9. Revise locations from those indicated in the Contract Documents, as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
 10. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.
 11. Identify those cells of cellular floor deck that are to be connected and fitted.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Project record documents.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Comply with UL 884.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Jacks, Receptacles, and Fittings:
 - 1. Comply with Section 262726 "Wiring Devices" for power outlets, faceplates, and connectors.
 - 2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for twisted pair jacks, outlets, assemblies, and faceplates.
 - 3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical fiber jacks, outlets, assemblies, and faceplates.
 - 4. Comply with Section 271533 "Communications Coaxial Horizontal Cabling" for coaxial jacks, outlets, assemblies, and faceplates.

2.2 FLAT-TOP, STEEL UNDERFLOOR RACEWAYS

- A. Description: Steel, rectangular, flat-top, single-channel raceways with premanufactured inserts.
- B. Manufacturers: Subject to compliance with requirements, **provide products by the following**:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide **the product indicated on** or a comparable product by one of the following:
 - 1. MonoSystems, Inc.
 - 2. Square D.
 - 3. Walker Systems, Inc.
- D. Source Limitations: Obtain underfloor raceway components for each system through single source from single manufacturer.
- E. Material: One-piece, continuous weld, minimum 0.0598-inch- thick steel, with corrosion-resistant galvanized coating inside and out after welding.
- F. Cross-Section Shape: Rectangular, with rounded corners.
- G. Number of Longitudinal Channels: Two Three Four, separated by steel wall(s).
- H. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch- Insert dimension minimum bending radius for communication cables.
- I. Service Raceways: Fitted with preset inserts.
 - 1. Nominal Multichannel Underfloor Raceway Dimensions:

- a. Depth: 1-3/8 inches.
 - b. Power Service Channel Width: 3-1/2 inches 4-3/8 inches.
 - c. Communication Service Channel Width: 3-1/2 inches 4 inches 6-1/2 inches.
2. Nominal Single-Channel Underfloor Raceway Dimensions:
 - a. Depth: 1-1/2 inches.
 - b. Power Service Raceway Width: 3-1/4 inches.
 - c. Communication Service Raceway Width: 3-1/4 inches 6 inches.
 - d. Number of Single-Channel Raceways per Run: One Two Three Four Five unless otherwise indicated.
 3. Preset Inserts: Rectangular Round.
 - a. Spacing: 12 inches 24 inches o.c.
 - b. Size: Rectangular dimensions as required to accommodate mounting and connection of flush- and surface-mounted, single- and multiple-outlet service fittings or to connect to wiring extensions for feeding wall outlets for power communications power and communications Insert system.
 - c. Size: 2 inches Insert dimension in diameter.
 - d. Equip each insert with a disposable cover, and select insert height so cover is 1/8 inch below surface of concrete.
 - e. Arrange insert for optional attachment of flush-, surface-, or wiring-extension service fitting to replace disposable cover. Arrange brackets, mountings, barriers, and floor access covers to support, isolate, and provide access to flush surface outlet-mounting connector, jack, and receptacle devices.
- J. Header Raceways: Single-Multichannel, without preset inserts (blank raceway).
1. Nominal Raceway Dimensions:
 - a. Depth: Same as service raceways.
 - b. Power Header Raceway Width: 3-1/2 inches 4-3/8 inches.
 - c. Communication Header Raceway Width: 3-1/2 inches 4 inches 6-1/2 inches.
 2. Arrangement: In same plane as Below service raceways.
 3. Connections: Arranged to connect with service raceways at single two-level junction boxes.

2.3 FLUSH, FLAT-TOP UNDERFLOOR RACEWAYS

- A. Description: Single or multichannel underfloor raceways installed on floor slab with top of raceway flush with concrete topping added hereafter, and then covered with finish material.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Walker Systems, Inc.
 2. .
- C. Source Limitations: Obtain underfloor raceway components for each system through single source from single manufacturer.
- D. Material: Steel.
- E. Cross-Section Shape: Rectangular, single channel multichannel, separated by steel wall(s).
- F. Listed and labeled for installation with top flush with concrete floor.
- G. Number of Levels: One.
- H. Service Raceways: Fitted with preset inserts.

1. Number of Longitudinal Channels per Multichannel Raceway: Two Three.
 2. Number of Single-Channel Raceways per Run: One Two Three unless otherwise indicated.
 3. Nominal Channel Dimensions: 3 inches wide by 1-1/4 inches deep.
 4. Preset Inserts: Threaded opening with removable steel plug that is flush with top of raceway when screwed in place.
 - a. Spacing: 12 inches 24 inches o.c., full length of each service raceway.
 - b. Arrangement: Stagger insert locations on parallel raceways or channels to accommodate placement of adjacent service fittings.
 - c. Size: 1-5/8-inch diameter.
- I. Trench Duct Crossunder: Fitting attached to underside of trench duct.
1. Nominal Channel Dimensions: Same as service raceways.
 2. Arrangement: Offset by depth of trench duct.
 3. Connections: Arranged to connect trench duct to flush duct through factory-cut, grommeted openings.
- J. Header Raceways: Raceways same as service raceways, except without preset inserts (blank raceway).
1. Nominal Channel Dimensions: Same as service raceways.
 2. Arrangement: In same plane as service raceways.
 3. Connections: Arranged to connect with service raceways at junction boxes.

2.4 CELLULAR METAL UNDERFLOOR RACEWAYS

- A. Description: Multichannel, cellular, underfloor service raceways installed on floor slab with top of raceway flush concrete topping added hereafter, and then covered with finish material.
- B. Manufacturers: Subject to compliance with requirements, **provide products by the following:**
- C. Basis-of-Design Product: Subject to compliance with requirements, provide **product indicated on Drawings** or comparable product by one of the following:
1. ASC Profiles, Inc.
 2. Dennis Filges Company, Inc.
 3. Epic Metals Corporation.
 4. HH Robertson.
 5. United Steel Deck, Inc.
 6. Walker Systems, Inc.
 7. Insert manufacturer's name.
- D. Source Limitations: Obtain underfloor raceway components for each system through single source from single manufacturer.
- E. Material: Galvanized-steel sheet, ASTM A 653/A 653M, Structural Steel (SS), Grade 33 minimum, G60 G90 zinc coating.
- F. Material: Galvanized- and shop-primed steel sheet, ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard gray white baked-on, rust-inhibitive primer.
- G. Number of Longitudinal Cells: Three, separated by steel walls.
- H. Nominal Dimensions of Cells:
1. Overall Depth: 1-1/4 inches unless otherwise indicated.
 2. Cross-Sectional Area of Cells: Power cells: 5-1/2 sq. in.; communication system cells: 16 sq. in..

- I. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch- Insert dimension minimum bending radius for communication cables.
- J. Service Raceways: Fitted with preset inserts.
 - 1. Preset Inserts: Rectangular-shaped metal housing assemblies arranged to provide electrical outlet access to each cell of each raceway designated for service raceway use. Inserts shall be provided throughout the entire length of each such raceway.
 - a. Spacing: 12 inches 24 inches 30 inches o.c.
 - b. Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-outlet service fitting.
 - c. Include mounting and connecting provisions for a surface, single- or multiple-outlet service fitting.
 - d. Include connecting provisions for a wiring-extension service fitting to feed wall outlets.
 - e. Equip each insert with a disposable cover plate arranged for installation with top 1/8 inch below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable top.
- K. Header Assembly: A junction box and raceway arrangement positioned to feed wires and cables to service raceways.
 - 1. Three-compartment junction box connecting blank, multicell cellular flat-top, multichannel header raceway (no inserts) with cellular service raceways at right angles to header raceway.
 - 2. Cellular header raceway shall be made of the same material and have the same nominal dimensions as service raceways.
 - 3. Provide capability for service raceways to be run in both perpendicular directions at the intersection with header raceway.

2.5 TRENCH-TYPE UNDERFLOOR RACEWAYS

- A. Description: Trench-type raceways used as header or feeder raceways to serve service raceways.
- B. Manufacturers: Subject to compliance with requirements, **provide products by the following** :
- C. Basis-of-Design Product: Subject to compliance with requirements, provide **product indicated on Drawings** or a comparable product by one of the following:
 - 1. Dennis Filges Company, Inc.
 - 2. HH Robertson.
 - 3. Hubbell Incorporated; Wiring Device-Kellems.
 - 4. Square D.
 - 5. Walker Systems, Inc.
 - 6. Insert manufacturer's name.
- D. Source Limitations: Obtain underfloor raceway components for each system through single source from single manufacturer.
- E. Trench: Steel, shop or factory welded and fabricated to indicated sizes. Include the following features:
 - 1. Slab Depth Adjustment: Minimum of minus 1/8 inch to plus 5/8 inch before and during concrete placement.
 - 2. Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.
 - 3. Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
 - 4. Trim Strip: Select to accommodate floor finish material.
 - 5. Partitions: Arranged to separate channels and isolate wiring of different systems.
 - 6. Grommeted openings in active floor cells or service raceways.
 - 7. Manufacturer's standard corrosion-resistant finish, applied after fabrication.

- F. Cover Plates: Removable, steel plates, 1/4 inch thick, each weighing 60 lb or less with full gasket attached to side units. Fabricate intermediate supports to limit unsupported spans to 15 inches. Insert dimension or less. Fabricate covers with appropriate depth recess to receive indicated floor finish.

2.6 SUPPORTS, RACEWAY FITTINGS, AND HARDWARE

- A. Source Limitations: Obtain underfloor raceway supports, fittings, and hardware components for each system through single source from single manufacturer.
- B. Supports, fittings, and hardware shall be compatible with raceway and outlet system and shall be listed for use with raceway systems and components delivered.
- C. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.
- D. Raceway Fittings: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.

2.7 JUNCTION BOXES

- A. Description: Raceway manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:
 - 1. Mounting brackets.
 - 2. Escutcheons and holders to accommodate surrounding floor covering.
 - 3. Means for leveling and height adjustment more than 3/8 inch before and after concrete is placed.
 - 4. Boxes shall withstand a minimum 300-lb concentrated load. Internal supports shall be provided as needed to meet this requirement.
 - 5. All boxes shall provide 2-inch- minimum bend radius for data and communication cables.
 - 6. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.
 - 7. Covers shall have appropriate depth recess to receive specific floor finish material.
 - 8. Partitions to separate wiring of different systems.

2.8 SERVICE FITTINGS/ACTIVATIONS

- A. Source Limitations: Obtain underfloor raceway service fittings and hardware for each system through single source from single manufacturer.
- B. Exposed Parts Finish: Brass Brushed aluminum Insert finish.
- C. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.
- D. Flush, Single- Multiple-System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.
 - 1. Recess-Mounted Service Fitting: Modular fittings compatible with preset inserts. Include device plates for indicated systems and provisions for receptacles, jacks, and connectors. Include hinged flush covers with recessed depth to match thickness of floor finish material. Provide for internally mounted receptacle- and communication-jack and connector assemblies.
- E. Surface-Mounted Service Fitting: Modular pedestal type, with locking attachment matched to insert floor opening.

1. Power-outlet, double-faced, surface-mounted unit for duplex receptacle on both sides.
2. Power-outlet, single-faced, surface-mounted unit for duplex receptacle on one side.
3. Communication-outlet, double-faced, surface-mounted unit.
 - a. Include bushed openings on both sides; 1-inch minimum diameter; insulated with nonconducting material.
 - b. Include provisions for modular dual fiber-optic connector assembly on both sides.
 - c. Include provisions for modular dual jack-connector assembly, rated for **Category 6** on both sides.
4. Communication-outlet, single-faced, surface-mounted unit with bushed opening on one side; 1-inch minimum diameter; insulated with nonconducting material.
5. Combination surface-mounted unit for duplex receptacle on one side and with communication cable connection provision on opposite side.
6. Flush-Mounted Service Fittings: Modular fittings compatible with preset inserts and shall include covers, provisions for receptacles jacks and connector assemblies and wiring extensions to wall-mounted outlets, and associated device plates for indicated systems. Include flush covers, recessed to suit floor finish material.
7. Indicate types and locations of devices on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install raceways aligned and leveled and, unless otherwise indicated, parallel or perpendicular to floor supports.
- B. Maintain arrangement of conductor services throughout the raceway system.
- C. Install a concrete mud slab for support of cellular metal, flush duct, or trench duct raceway. Construct mud slab with wire mesh in the top 1 inch of concrete.
- D. Install a vapor barrier between the cellular metal raceway and a substrate in contact with earth.
- E. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Fasten supports securely at ends and at intervals not to exceed 60 inches, to prevent movement during concrete pour.
- F. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.
- G. Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of the Work.
- H. Install preset inserts per manufacturer's instructions.
- I. Adjust supports to maintain a 1/8- to 3/8-inch finished concrete cover over preset inserts.
- J. Remove burrs, sharp edges, dents, and mechanical defects.

- K. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.
- L. Install expansion fittings with suitable bonding jumper where raceways cross building expansion joints.
- M. Bond underfloor raceway components to create a continuous bonding path.
- N. Seal raceways, cells, junction boxes, and inserts, as recommended in writing by underfloor raceway manufacturer, to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill.
- O. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.
 - 1. Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
 - 2. Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications, and use another distinctive screw head to identify third system, such as special-purpose wiring.
- P. Protect underfloor raceway system from damage. Do not use the installed duct system as working platforms or walkways. Do not allow equipment or heavy traffic over duct during construction period, without first installing ramps over the duct. Ramps shall be designed so that imposed loads are not transferred to the duct. Components of the system that are damaged during construction shall be replaced.
- Q. Install concrete surrounding underfloor raceways according to Section 033000 "Cast-in-Place Concrete."
- R. Afterset Inserts: Cut, hole saw, and drill slab and raceways to allow for installation at locations indicated on plans.
- S. Wiring shall comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and NFPA 70 requirements for wet locations.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: **Owner will engage** a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections **with the assistance of a factory-authorized service representative**:
 - 1. Perform visual inspection of interior of each **junction box** to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
 - 2. Prior to and after concrete pour, perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.
 - a. Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 ohms.
 - b. Comply with NETA Acceptance Testing Specification about safety, suitability of test equipment, test instrument calibration, and test report and records.
- D. Prepare test and inspection reports.

3.4 CLEANING

- A. Clean and swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

END OF SECTION 260539

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 2. Include underground-line warning tape.

1.3 INFORMATIONAL SUBMITTALS

- A. Profile Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.

1.4 MAINTENANCE MATERIALS SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than five days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

- C. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Anamet Electrical, Inc.
 - 4. Calconduit.
 - 5. Electri-Flex Company.
 - 6. FSR Inc.
 - 7. Korkap.
 - 8. Opti-Com Manufacturing Network, Inc (OMNI).
 - 9. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 10. Perma-Cote.
 - 11. Picoma Industries, Inc.
 - 12. Plasti-Bond.
 - 13. Republic Conduit.
 - 14. Southwire Company.
 - 15. Thomas & Betts Corporation; A Member of the ABB Group.
 - 16. Topaz Electric; a division of Topaz Lighting Corp.
 - 17. Western Tube and Conduit Corporation.
 - 18. Wheatland Tube Company.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. CANTEX INC.
 - 4. CertainTeed Corporation.
 - 5. Condux International, Inc.
 - 6. Crown Line Plastics.
 - 7. ElecSys, Inc.
 - 8. Electri-Flex Company.
 - 9. Endot Industries Inc.
 - 10. IPEX USA LLC.
 - 11. Lamson & Sessions.
 - 12. Manhattan/CDT.
 - 13. National Pipe & Plastics.
 - 14. Opti-Com Manufacturing Network, Inc (OMNI).
 - 15. Spiraduct/AFC Cable Systems, Inc.

- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 FLEXIBLE NONMETALLIC DUCTS

- A. HDPE Duct: Type EPEC-40 HDPE Type EPEC-80 HDPE, complying with NEMA TC 7 and UL 651A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following one of:
 - a. ARNCO Corp.
 - b. Carlon; a brand of Thomas & Betts Corporation.
 - c. National Pipe & Plastics.
 - d. Opti-Com Manufacturing Network, Inc (OMNI).
 - e. Premier Conduit
 - 2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.4 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. CANTEX INC.
 - c. Carlon; a brand of Thomas & Betts Corporation.
 - d. IPEX USA LLC.
 - e. PenCell Plastics.
 - f. Underground Devices, Inc.
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
- C. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - 1. Color: Red dye added to concrete during batching.
 - 2. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

2.5 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Christy Concrete Products.
 - 2. Elmhurst-Chicago Stone Co.
 - 3. Oldcastle Precast, Inc.
 - 4. Rinker Group, Ltd.
 - 5. Riverton Concrete Products.
 - 6. Utility Concrete Products, LLC.
 - 7. Utility Vault Co.
 - 8. Wausau Tile Inc.

- C. Comply with ASTM C 858 for design and manufacturing processes.
- D. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2. Cover Handle: Recessed.
- E. Cover Legend: Molded lettering, "ELECTRIC."
- F. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
- G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- H. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - 1. Center window location.
 - 2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - 3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 - 4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - 5. Knockout panels shall be 1-1/2 to 2 inches thick.

2.6 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- B. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- C. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
- B.
 - 1. Armorcast Products Company.
 - 2. Christy Concrete Products.
 - 3. Oldcastle Enclosure Solutions.
 - 4. Quazite: Hubbell Power Systems, Inc.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

- E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- G. Cover Legend: Molded lettering, "ELECTRIC."
- H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Cables More Than 600 V: Type EPC-80-PVC RNC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- C. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- D. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- E. Bored Underground Duct: Type EPEC-40-HDPE unless otherwise indicated.
- F. Underground Ducts Crossing Paved Paths Walks and Driveways Roadways: Type EPC-40 PVC RNC, encased in reinforced concrete.
- G. Stub-ups: Concrete-encased RNC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
 5. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area .
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Radial separation for gas or other lines that transport flammable materials measured from the nearest duct in the conduit shall not be less than 12" AND sufficient separation for pipe maintenance equipment. per NESC Rule 320B5.
- C. Electrical conduit shall not enter the same manhole, handhole, or vault with gas or flammable material lines.
- D. Install duct according to NEMA TCB 2.
- E. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- F. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.
- G. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

- H. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- I. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.
1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- J. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.
 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.
- K. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- L. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- M. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.
- N. Concrete-Encased Ducts and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 2. Width: Excavate trench 12 inches wider than duct on each side.
 3. Width: Excavate trench 3 inches wider than duct on each side.
 4. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than **four** spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 7. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
 8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
 9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

- b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be **flush with** finished floor and minimum 3 inches from conduit side to edge of slab
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be **flush with** finished floor and no less than 3 inches from conduit side to edge of slab
 10. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 12. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
 13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
 14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
- O. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
 2. Width: Excavate trench 12 inches wider than duct on each side.
 3. Width: Excavate trench 3 inches wider than duct on each side.
 4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
 5. Set elevation of bottom of duct bank below frost line.
 6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than **four** spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
 9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

- a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be **flush with** finished floor and minimum 3 inches from conduit side to edge of slab
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be **flush with** finished floor and no less than 3 inches from conduit side to edge of slab
11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
- a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
 - b. Place minimum 6 inches of engineered fill above concrete encasement of duct.
- P. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.
- Q. Underground-Line Warning Tape: Bury **nonconducting** underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks **and approximately 12 inches below grade**. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Cast-in-Place Manhole Installation:
1. Finish interior surfaces with a smooth-troweled finish.
 2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
 3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.
- B. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 3. Install handholes with bottom below frost line, below grade.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Dampproofing: Apply dampproofing to exterior surfaces of manholes **and handholes** after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- E. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

- F. For enclosures installed in and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep.

3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 2. Sleeve-seal systems.
 3. Sleeve-seal fittings.
 4. Grout.
 5. Silicone sealants.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
1. Material: Galvanized sheet steel.
 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.

3. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Stainless steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

- b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed[or unless seismic criteria require different clearance].
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Restraint channel bracings.
 2. Restraint cables.
 3. Seismic-restraint accessories.
 4. Mechanical anchor bolts.
 5. Adhesive anchor bolts.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated-Design Submittal: For each seismic-restraint device.
1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic[and wind] forces required to select seismic[and wind] restraints.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 3. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic[and wind] restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES , showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: A .
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I.
 - a. Component Importance Factor: 1.0 .
 - b. Component Response Modification Factor: 1.5.
 - c. Component Amplification Factor: 1.0.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second)
 - 4. Design Spectral Response Acceleration at 1.0-Second Period:

2.2 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Cooper B-Line, Inc.; a Division of Cooper Industries.
 - 2. Hilti, Inc.
 - 3. Mason Industries, Inc.
 - 4. Unistrut; Atkore International.
- C. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.

- C. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper B-Line, Inc.; a Division of Cooper Industries.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. TOLCO; a brand of NIBCO INC.
- C. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- D. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper B-Line, Inc.; a Division of Cooper Industries.
 2. Hilti, Inc.
 3. Kinetics Noise Control, Inc.
 4. Mason Industries, Inc.
- C. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.

- C. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by **an evaluation service member of ICC-ES**.

- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 2. Install seismic-restraint devices using methods approved by **an evaluation service member of ICC-ES**.

- B. Install cables so they do not bend across edges of adjacent equipment or building structure.

- C. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

- E. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 2. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 3. Test to 90 percent of rated proof load of device.
- B. Seismic controls will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548.16

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with **NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis"** requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, **ambient**; 180 deg F, **material surfaces**.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.

3. Colors for 240-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 4. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 5. Color for Neutral:
 - a. 208/120-V or 120/240-V Circuits: White.
 - b. 480/277-V Circuits: Grey.
 6. Color for Equipment Grounds: Green.
 7. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
1. Black letters on an orange field.
 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
- F. Equipment Identification Labels:
1. Black letters on a white field.

2.3 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by the following:
1. Brady Corporation.
 2. Carlton Industries, LP.
 3. Champion America.
 4. emedco.
 5. Hellermann Tyton
 6. Ideal Industries, Inc.
 7. LEM Products Inc.
 8. Marking Services, Inc.
 9. Panduit Corp.
 10. Seton Identification Products.

2.4 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, polyester flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.5 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.6 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
- C. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
- D. Underground-Line Warning Tape:
 1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" .
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE" .
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.7 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch/0.58 mm thick, color-coded for phase and voltage level, with factory screened permanent designations; punched for use with self-locking cable tie fastener.
 - 1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.8 SIGNS

- A. Baked-Enamel Signs:
 - 1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal Size: 7 by 10 inches.
- B. Metal-Backed Butyrate Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal Size: 10 by 14 inches.
- C. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face .
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.9 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for **power transfer, load shedding, etc..**
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- M. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
- U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- V. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench [or concrete envelope]exceeds 16 inches overall.
 2. Limit use of underground-line warning tape to direct-buried cables.
- W. Tags:
1. Place in a location with high visibility and accessibility.
 2. Secure using **general-purpose** or **plenum-rated** cable ties.
- X. Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.
- Y. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 1. "EMERGENCY POWER."
 2. "POWER."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use snap-around color-coding bands or self-adhesive vinyl tape to identify the phase.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- I. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- L. Workspace Indication: Apply floor marking tape] to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- M. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs or Metal-backed, butyrate warning signs.
 1. Apply to exterior of door, cover, or other access.
 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- O. Arc Flash Warning Labeling: Self-adhesive labels.

- P. Operating Instruction Signs: Baked-enamel warning signs, Metal-backed, butyrate warning signs or Laminated acrylic or melamine plastic signs.
- Q. Emergency Operating Instruction Signs: Baked-enamel warning signs, Metal-backed, butyrate warning signs ,minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer,load shedding,etc..
- R. Equipment Identification Labels:
 - 1. Indoor Equipment: Baked-enamel signs.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 - 3. Equipment to Be Labeled:
 - a. Enclosures and electrical cabinets.
 - b. Access doors and panels for concealed electrical items.
 - c. Enclosed switches.
 - d. Push-button stations.
 - e. Contactors.
 - f. Remote-controlled switches, dimmer modules, and control devices.
 - g. Monitoring and control equipment.
 - 4. Include the following information on equipment labels:
 - a. Equipment Identification per the Drawings
 - b. Source of power: (e.g., "Fed From PP-1A")
 - c. What is fed (e.g., "Feeds EF-3")

END OF SECTION 260553

SECTION 260573 – POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes services necessary to complete the system analysis studies required for the item specified under this Division, including but not limited to:
 - 1. Short circuit study
 - 2. Protective device evaluation study
 - 3. Protective device coordination study
 - 4. Arc Flash Hazard Analysis study

1.2 SCOPE

- A. Provide power system studies for all new equipment and existing equipment as indicated on Drawings.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following prior to approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Power system study input data, including completed computer program input data sheets.
 - 2. Power system study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals, including but not limited to panelboards, transformers, switchboards, switchgear, substations, transfer switches, generators, motor controllers, and disconnect switches. If formal completion of studies will cause delay in equipment manufacturing, provide preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
 - b. Revised single-line diagram, reflecting field investigation results and results of power system studies.
 - 3. The results of the Studies shall be summarized in a final report. Submitted for review and approval.
 - 4. The report shall include the following Sections:
 - a. Executive Summary.
 - b. Description, purpose, basis and scope of the study. Provide single line diagrams for the entire system and also for each specific portion of the power system study.
 - c. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding it.
 - d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding it.
 - e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
 - f. Details of the incident energy and flash protection boundary calculations.
 - g. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays.
 - h. Recommendations for system improvements, where needed.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Power System Study Specialist.

- B. Product Certificates: For power system study software, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Power System Study Specialist Qualifications:
1. Firms: Subject to compliance with the requirements, engage one of the following firms to perform the specified power system studies:
 - a. KSG Consulting Engineers, Inc.
 - b. Applied Engineering Concepts.
 2. Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer. Specialist shall have a minimum of ten years experience in power system analysis.
 3. Company performing the study shall be an independent consulting/testing company not involved on the project.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- E. Sequencing:
1. Submit study reports prior to or concurrent with product submittals.
 2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
 3. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable).

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Software Developers: Subject to compliance with requirements, perform studies utilizing software by the following:
1. SKM Systems Analysis, Inc.
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of fault-current-study computer software program shall have the capability to calculate mandatory features as listed in IEEE 399.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. The report shall be neatly bound in a 8-1/2" x 11" folder or binder with a table of contents and separate tabs for each section of the report.
- B. Executive summary.
- C. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
- D. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- E. Comments and recommendations for system improvements, where needed.
- F. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
- G. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- H. Short-Circuit Study Output:
 - 1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 - 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 - 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.

- e. Equivalent impedance.
- f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
- g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

2.3 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. The report shall be neatly bound in a 8-1/2" x 11" folder or binder with a table of contents and separate tabs for each section of the report.
- B. Executive summary.
- C. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- D. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- E. Study Input Data: As described in "Power System Data" Article.
- F. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 - 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 - 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 - 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.

- d. Transformer full-load current, magnetizing inrush current.
 - e. Ground-fault protective devices.
 - f. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Provide adequate time margins between device characteristics such that selective operation is achieved.
 6. Comments and recommendations for system improvements.

2.4 ARC-FLASH STUDY REPORT CONTENT

- A. The report shall be neatly bound in a 8-1/2" x 11" folder or binder with a table of contents and separate tabs for each section of the report.
- B. Executive summary.
- C. Study descriptions, purpose, basis and scope.
- D. One-line diagram, showing the following:
 1. Protective device designations and ampere ratings.
 2. Cable size and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center and panelboard designations.
- E. Study Input Data: As described in "Power System Data" Article.
- F. Arc-Flash Study Output:
 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- G. Incident Energy and Flash Protection Boundary Calculations:
 1. Arcing fault magnitude.
 2. Protective device clearing time.
 3. Duration of arc.
 4. Arc-flash boundary.
 5. Working distance.
 6. Incident energy.
 7. Hazard risk category.
 8. Recommendations for arc-flash energy reduction.
 9. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the study.

1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
 2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
- B. Electrical Survey Data: Gather and tabulate the following input data to support the power system study:
1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Obtain electrical power utility impedance at the service.
 3. Power sources and ties.
 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 5. For generators, include voltage rating, power rating (kW/kVA), and alternator sub-transient reactance values.
 6. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 7. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 9. Motor horsepower and NEMA MG 1 code letter designation.
 10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Begin short-circuit current analysis at the utility service, extending down to the system overcurrent protective devices as follows:
1. To normal system low-voltage load buses where fault current is 10 kA or less, or as required to satisfy coordination study and arc-flash study requirements.
- D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- E. The calculations shall include the ac fault-current decay from induction motors. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
1. Electric utility's supply termination point.
 2. Generators.
 3. Incoming switchgear.
 4. Low-voltage switchgear / switchboard
 5. Medium voltage pad mounted transformer.
 6. Motor-control centers.
 7. Control panels.
 8. Automatic transfer switches.
 9. Power distribution panelboards.

10. Branch circuit panelboards.
11. Disconnect switches.

- G. Equipment short-circuit ratings and protective device interrupting ratings shall be selected based on the results of the fault current study.

3.3 PROTECTIVE DEVICE COORDINATION STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- C. Evaluate overcurrent protective devices serving transformers and verify that the devices will not open upon energization of the transformer. Where device rating and/or type must be changed to avoid opening upon energization, notify the Contractor and Architect and record recommended device changes in the report.
- D. Evaluate overcurrent protective device coordination against project selective coordination criteria. Where the system devices and/or configuration cannot achieve the required selective coordination criteria, evaluate alternate overcurrent device selections that will meet the criteria and record recommendations in the report.

3.4 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Calculate maximum and minimum contributions of fault-current size.
1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- C. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts. The following modes of operations must be considered:
1. Mode #1: Normal Utility Operation (Utility power on and all automatic transfer switches in normal operating configuration)
 2. Mode #2: Emergency Generator Operation (generators on-line with automatic transfer switches in their emergency/standby position operating configuration)
- D. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- E. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors shall be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond three to five cycles.
- F. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
1. When the circuit breaker is in a separate enclosure.
 2. When the line terminals of the circuit breaker are separate from the work location.
- G. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

- H. Labels: Print and install labels for each modeled piece of electrical equipment. Provide green bordered labels for PPE category 0 & 1, yellow bordered labels for PPE category 2 & 3, and red bordered labels for PPE category 4 & dangerous. Labels shall have flash protection and shock protection and shall include:
1. Flash Hazard in inches
 2. Arc Flash rating in cal/sq. cm
 3. Flash protection boundary in inches
 4. Glove class
 5. PPE clothing category
 6. Shock hazard in volts
 7. Limited Approach distance in inches
 8. Restricted Approach distance in inches
 9. Prohibited Approach distance in inches
 10. Bus Designation
 11. Upstream overcurrent protection designation
 - a. Where applicable: Indication if values are based on "maintenance mode" on or off. Where temporary settings are utilized in the upstream overcurrent protection device for arc energy reduction purposes, provide two separate labels for each condition.
 12. Oversize print of Warning or Danger

3.5 EQUIPMENT MODIFICATIONS

- A. Notify the University's Representative in writing of any required major equipment modifications.

3.6 ADJUSTING

- A. The drawings and specifications indicate the general requirements for the electrical equipment being provided. Upgrades and modifications to equipment characteristics and ratings will be finalized by the results of the Short Circuit and Protective Device Coordination Studies.
- B. Field settings of devices, adjustments, upgrading and modifications to the new equipment to accomplish conformance with the accepted Short Circuit, Protective Device Coordination and Arc Flash Studies, shall be carried out by the Contractor at no additional cost. The Contractor shall not be responsible for upgrading the existing equipment unless otherwise noted.
- C. Set field-adjustable overcurrent protective devices to the recommended settings based on results from the power systems studies.
- D. The equipment manufacturer shall provide the services of a qualified field engineer and necessary tools and equipment to test and calibrate protective relays, ground fault and circuit breaker trip devices as recommended by the study.

3.7 DEMONSTRATION

- A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes Cx process requirements for the following electrical components, systems, assemblies, and equipment:
1. Electrical equipment connected to Normal power systems, including the following:
 - a. Transformers.
 - b. Primary and secondary service electrical systems.
 - c. Distribution and branch-circuit panelboards.
 - d. Grounding systems.
 2. Electrical equipment connected to Essential power systems that provide an alternative source of power in the absence of power from the Normal power system, including the following:
 - a. Transformers
 - b. Distribution and branch-circuit panelboards.
 - c. Grounding systems.
 - d. Generators.
 - e. UPS.
 - f. Central Lighting Inverters
 3. Controls and instrumentation, including the following:
 - a. Electrical metering and metering system.
 - b. Lighting control systems.
 - c. Security systems.
 - d. Fire-alarm systems.
 4. Systems testing and verification, including Normal and Essential power systems, and transitions from Normal to Essential power systems and back.
- B. Related Requirements:
1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.

1.2 DEFINITIONS

- A. BoD: Basis-of-Design Document, as defined in Section 019113 "General Commissioning Requirements."
- B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
- C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
- D. Essential Power Systems: A power system that a facility transitions to in the absence of Normal power. This power includes all systems classified as "standby" or "emergency," including "legally required."
- E. Low Voltage: 600 V and below.
- F. Medium Voltage: 601 V and above.
- G. Normal Power Systems: A power system that provides primary power to a facility.
- H. OPR: Owner's Project Requirements, as defined in Section 019113 "General Commissioning Requirements."

- I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Construction Checklists: Include the following and comply with requirements in Section 019113 "General Commissioning Requirements" for construction checklists:

1. Instrumentation and control for lighting control systems.
2. Low-voltage power cables.
3. Electrical feeders and branch circuits.
4. Liquid-filled transformers.
5. Dry-type transformers.
6. Instrument transformers.
7. Switchgear and switchboard assemblies rated 1200 A or greater.
8. Low-voltage motor starters.
9. Low-voltage insulated case circuit breakers.
10. Low-voltage air switches.
11. Low-voltage surge protective devices.
12. Medium-voltage power cables.
13. Medium-voltage vacuum circuit breakers.
14. Medium-voltage air switches.
15. Metering devices.
16. Molded-case circuit breakers.
17. Grounding systems.
18. Ground-fault protection systems.
19. Panelboards.
20. Receptacles and devices.
21. Engine generators.
22. Automatic transfer switches.
23. Variable-frequency drives.
24. AC synchronous motors and generators.
25. UPS systems.
26. Central Lighting Inverters
27. Lighting.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electrical systems and components to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform electrical Cx work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
 - a. Equipment/instrument identification number.
 - b. Planned Cx application or use.
 - c. Manufacturer, make, model, and serial number.
 - d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
2. Test equipment and instrumentation shall meet the following criteria:
 - a. Capable of testing and measuring performance within the specified acceptance criteria.

- b. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
 - c. Be maintained in good repair and operating condition throughout duration of use on Project.
 - d. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- B. Proprietary Test Instrumentation and Tools:
- 1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:
 - a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
 - 1) Instrument or tool identification number.
 - 2) Equipment schedule designation of equipment for which the instrument or tool is required.
 - 3) Manufacturer, make, model, and serial number.
 - 4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
 - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
 - c. Electrical proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLIST REVIEW

- A. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.
- B. Return draft Construction Checklist review comments within 10 days of receipt.
- C. When review comments have been resolved, CxA will provide final construction checklists, marked "Approved for Use, (date)."
- D. Use only construction checklists, marked "Approved for Use, (date)."

3.2 GENERAL TESTING REQUIREMENTS

- A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved Shop Drawings and submittals.
- B. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- C. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

- D. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.
- E. Construction Checklists: Prepare and submit detailed construction checklists for electrical systems, subsystems, equipment, and components.
 - 1. Contributors to development of construction checklists shall include, but are not limited to, the following:
 - a. Electrical systems and equipment installers.
 - b. Electrical instrumentation and controls installers.
 - c. Manufacturer representative
- F. Perform tests using design conditions, whenever possible.
 - 1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
 - 2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
 - 3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- G. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.
- H. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.
- I. Coordinate schedule with, and perform Cx activities at the direction of the CxA.
- J. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying electrical systems and equipment.
- K. Provide technicians, instrumentation, tools, and equipment to complete and document the following:
 - 1. Performance tests.
 - 2. Demonstration of a sample of performance tests.
 - 3. Cx tests.
 - 4. Cx test demonstrations.

3.3 Cx TESTS FOR ELECTRICAL SYSTEMS

- A. Verification of Normal Power System Operation:
 - 1. Prerequisites: Acceptance of results for construction checklists for Division 26 electrical components associated with Normal power system.
 - 2. Equipment and Systems to Be Tested: Division 26 electrical equipment.
 - 3. Test Purpose: Verify operation of Normal power system.
 - 4. Test Conditions: Energize components of Normal power system, one at a time.
 - 5. Acceptance Criteria: Proper operation of Normal power system over a 48 -hour period.
- B. Verification of Essential Power System Operation:
 - 1. Prerequisites:

- a. Acceptance of results for construction checklists for Division 26 electrical components associated with Essential power system.
 - b. Completion of "Verification of Normal Power System Operation" tests.
 2. Equipment and Systems to Be Tested: Division 26 electrical equipment.
 3. Test Purpose: Verify operation of Essential power system.
 4. Test Conditions:
 - a. Energize components of Normal power system.
 - b. Simulate a failure of Normal power system.
 5. Acceptance Criteria: Transfer of power from Normal to Essential power system within OPR.
- C. Verification of Control and Instrumentation:
1. Prerequisites: Acceptance of results for construction checklists.
 - a. Section 260943 "Network Lighting Controls."
 - b. Section 262713 "Electricity Metering."
- D. Test Purpose: Verify operation of control and monitoring systems for Normal and Essential power systems.
- E. Test Conditions:
1. Energize components of Normal power system.
 2. Test operation of equipment.
- F. Acceptance Criteria: Operation of equipment according to OPR.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 ACTION SUBMITALLS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
 - 2. Interconnection diagrams showing field-installed wiring, all devices and equipment shown on reflected ceiling plans, drawn to scale.
 - 3. Include diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which equipment will be attached.
 - 3. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Control modules.
- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's warranties.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.

- b. Faulty operation of lighting control devices.
- 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide products compatible with system specified in Section 260943 "Network Lighting Controls".

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS, ANALOG

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Building Automation, Inc.
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 4. WattStopper; a Legrand? Group brand.
- B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 - 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 - 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack, to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
 - 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- E. Power Pack: Dry contacts rated for LED load at 120- and 277-V ac, for tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 1. LED status lights to indicate load status.
 - 2. Plenum rated.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Building Automation, Inc.
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 4. WattStopper; a Legrand? Group brand.
- B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.

1. Lighting control set point is based on the following two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack, to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- E. Power Pack: Digital controller capable of accepting three RJ45 inputs with two output(s) rated for 20-A incandescent LED load at 120- and 277-V ac, for LED at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.
1. With integral current monitoring.
 2. Compatible with digital addressable lighting interface.
 3. Plenum rated.

2.4 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. General Requirements for Sensors:
1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 2. Dual technology.
 3. Separate power pack.
 4. Hardwired connection to switch; and BAS and lighting control system.
 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. Operation:
 - a. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 7. Sensor Output: Sensor is powered from the power pack.
 8. Power: Line voltage.
 9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 10. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 12. Bypass Switch: Override the "on" function in case of sensor failure.
 13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

- B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 - 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.

2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Building Automation, Inc.
 - 2. Leviton Manufacturing Co., Inc.
 - 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 4. Lutron Electronics Co., Inc.
 - 5. WattStopper.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, and shall comply with California Title 24.
 - 2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 - 4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag OS:
 - 1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. 196 sq. m
 - 2. Sensing Technology: Dual technology - PIR and ultrasonic.
 - 3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
 - 4. Capable of controlling load in three-way application.
 - 5. Voltage: 277 V.
 - 6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 - 7. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
 - 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
 - 9. Color: White.
 - 10. Faceplate: Color matched to switch.
- D. Wall-Switch Sensor Tag OSD:
 - 1. Same as type OS except with 0-10V dimming capability.

2.6 DIGITAL TIMER LIGHT SWITCH

- A. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.
1. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
 2. Standards: Comply with UL 20.
 3. Integral relay for connection to BAS.
 4. Voltage: Match the circuit voltage.
 5. Color: White.
 6. Faceplate: Color matched to switch.

2.7 LIGHTING CONTACTORS

- A. Description: Electrically operated and electrically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.

2.8 EMERGENCY LIGHTING CONTROL RELAY

- A. Description: Emergency lighting control relay which bypasses all local dimming/switching controls upon loss of normal power.
1. Voltage: 120V or 277V as required to match circuit voltage.
 2. Dimming: Capable of acception 0-10V dimming signal and passing through the signal during normal operation. Relay shall bring the connected light fixtures to full brightness upon loss of normal power.
 3. Current rating: 16A, minimum.
 4. Compatible Load Types: LED.
 5. Status Indicators: LED type, with individual indicators for Normal Power, Test, and Emergency Power.
 6. Test Switch: Visible momentary contact switch.
 7. UL 924 Listed.

2.9 BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bodine.
 2. Hubbell.
 3. ETC.
- B. Description: Emergency lighting transfer device which automatically transfers to an emergency power source upon loss of power and overrides all local dimming/switching controls.
1. Voltage: 120V or 277V.
 2. Current Rating: 16A, minimum.
 3. Compatible Load Types: Incandescent, halogen, magnetic ballasts, electronic ballasts, LED drivers.
 4. Status Indicators: LED type, with individual indicators for Normal Power, Test, and Emergency Power.
 5. Test Switch: Visible momentary contact switch.
 6. UL 1008 Listed.

2.10 MINI EMERGENCY LIGHTING INVERTER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bodine or approved equal.

- B. Description: Emergency lighting inverter with ratings under 1000VA which instantly provides power to the load for 90 minutes upon loss of power.
 - 1. Voltage 120V or 277V
 - 2. Maximum Power Load: 100VA, 250VA, or 400VA as indicated on Drawings. Where ratings are not indicated on Drawings, provide inverter with a rating equal to the connected load plus 20% spare capacity.
 - 3. 0-10VDC dimming output. 250VA unit dimming output shall be automatically controlled in emergency mode as required to prevent overload. 100VA unit shall have DIP switches to allow field adjustment of emergency mode dimming level.
 - 4. Output Waveform: Sinusoidal.
 - 5. Compatible Load Types: Incandescent, halogen, magnetic ballasts, electronic ballasts, LED drivers.
 - 6. Batteries: Sealed lead-calcium.
 - 7. In-rush Current: Shall be capable of withstanding in-rush current of LED drivers in light fixtures indicated to be connected to the inverter.
 - 8. Status Indicators: LED type.
 - 9. Test Switch: Visible momentary contact switch.

2.11 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

- A. Comply with NECA 1.

- B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in other sections.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 DEFINITIONS

- A. BAS: Building automation system.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- C. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
- D. UTP: Unshielded twisted pair.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- B. Field quality-control reports.
- C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- D. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.
- E. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of lighting control functions.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of software input/output to execute switching or dimming commands.
 - b. Failure of modular relays to operate under manual or software commands.
 - c. Damage of electronic components due to transient voltage surges.
 - 2. Warranty Period: Two years from date of Substantial Completion.
 - 3. Extended Warranty Period Failure Due to Transient Voltage Surges: [Eight] <Insert number> years.
 - 4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

1.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Acuity Brands Lighting, Inc.; Lithonia Lighting brand.
 - 2. Intelligent Lighting Controls.
 - 3. Leviton Mfg. Company Inc.
 - 4. Lighting Control & Design, Inc.
 - 5. Lightolier Controls; a division of Genlyte Group, LLC.
 - 6. Lutron Electronics Co., Inc.
 - 7. Musco Lighting.
 - 8. NexLight; part of the Northport Engineering Group.
 - 9. Square D; a brand of Schneider Electric.
 - 10. Starfield Controls, Inc.
 - 11. Touch-Plate Technologies.
 - 12. Triatek, Inc.
 - 13. Watt Stopper/Legrand.

2.2 SYSTEM REQUIREMENTS

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
- B. Performance Requirements: Manual switch operation sends a signal to network-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.
- C. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
 - 1. Hardwired Points:
 - a. Monitoring: On-off status.
 - b. Control: On-off operation.

2.3 CONTROL MODULE

- A. Control Module Description: Programmable, PC-based unit with 17-inch color video monitor and keyboard for graphic display and programming of system status and to override breaker status; and to display status of local override controls and diagnostic information. If the control module is applied to emergency lighting units, control unit shall indicate failure of normal power and that the lighting units are, or are not, powered by the alternate power source.
 - 1. Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.
 - 2. Energy Conservation: Bilevel control of special ballasts or dimming circuits to comply with local energy codes.
 - 3. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

4. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.
5. Additional Programming: In addition to system programming by the PC, individual control modules shall be networked and programmable using data-entry and -retrieval (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs).

2.4 MANUAL ANALOG SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
 1. Match color specified in Section 262726 "Wiring Devices."
 2. Integral green LED pilot light to indicate when circuit is on.
- B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 262726 "Wiring Devices."
- C. Wall-Box Dimmers: Comply with Section 262726 "Wiring Devices."
- D. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."
- E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.5 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

- A. Connection Type: RS-485 protocol, category 5e UTP cable, using RJ45 connectors. Power shall be from the control unit.
- B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
 1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Section 262726 "Wiring Devices."
 2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring in raceways **except where installed in accessible ceilings**. Minimum conduit size shall be 1/2 inch.

1. For power wiring comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Section 260523 "Control-Voltage Electrical Power Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
- G. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
1. Test for circuit continuity.
 2. Verify that the control module features are operational.
 3. Check operation of local override controls.
 4. Test system diagnostics by simulating improper operation of several components selected by Architect.
- E. Lighting controls will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.3 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. See Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 261219 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pad-mounted, liquid-filled, medium-voltage distribution transformers, with primary and secondary bushings within or without air-terminal enclosures.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For pad-mounted, liquid-filled, medium-voltage transformers.
 - 1. Include plans and elevations showing major components and features.
 - a. Include a plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.
 - 2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include single-line diagram.
 - 4. Include list of materials.
 - 5. Include nameplate data.
 - 6. Manufacturer's published time-current curves of the transformer high-voltage fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For transformer assembly, accessories, and components, from manufacturer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 WARRANTY

- A. Manufacturer Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of transformer that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Comply with IEEE C2.
- C. Comply with IEEE C57.12.00.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: The transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."
- B. Windings Material: Copper.
- C. Winding Connections: The connection of windings and terminal markings shall comply with IEEE C57.12.70.
- D. Efficiency: Comply with 10 CFR 431, Subpart K.
- E. Insulation: Transformer kVA rating shall be as follows: The average winding temperature rise above a 30 deg C ambient temperature shall not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested according to IEEE C57.12.90, using combination of connections and taps that give the highest average winding temperature rise.
- F. Tap Changer: External handle, for de-energized operation.
- G. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.
- H. Mounting: An integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.
- I. Insulating Liquids:
 - 1. Less-Flammable Liquids:
 - a. Edible-Seed-Oil-Based Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic, having passed the Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and shall be certified by the U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.
 - b. Biodegradable and Nontoxic Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92.
- J. Sound level shall comply with NEMA TR 1 requirements.
- K. Corrosion Protection:
 - 1. Transformer coating system shall be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.
 - 2. Base and Cabinets of Two Compartment Transformers: Fabricate from stainless steel according to ASTM A 167, Type 304 or 304L, not less than No. 13 U.S. gage. Coat transformer with manufacturer's standard green color coating complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

2.3 THREE-PHASE TRANSFORMERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Square D, Schneider Electric
 2. ABB.
 3. Cooper Industries; Cooper Power Systems Division.
 4. Eaton Corporation; Electrical Sector.
 5. General Electric Company; Electrical Distribution & Control Products.
- B. Description:
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with IEEE C57.12.26.
- C. Compartment Construction:
1. Double-Compartment Construction: Individual compartments for high- and low-voltage sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with a stop in the open position and provision for padlocking.
- D. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.
1. 125-kV BIL current-limiting fuses, conforming to requirements of IEEE C37.47.
 2. Interrupting Rating: 50,000 rms A symmetrical at system voltage.
 3. Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse shall sense both high currents and high oil temperature to provide thermal protection to the transformer.
 4. Provide bayonet fuse assembly with an oil retention valve and an external drip shield inside the housing to eliminate or minimize oil spills. Valve shall close when fuse holder is removed and an external drip shield is installed.
 5. Provide a conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.
- E. High-Voltage Section: Dead-front design.
1. To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 260513 "Medium-Voltage Cables." Bushings shall be one-piece units, with ampere and BIL ratings the same as connectors.
 2. Bushing inserts[and feed-through inserts]:
 - a. Conform to the requirements of IEEE 386.
 - b. Rated at 200 A, with voltage class matching connectors. Provide a parking stand near each bushing well. Parking stands shall be equipped with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.
 3. Access to liquid-immersed fuses.
 4. Ground pad.
- F. Low-Voltage Section:
1. Bushings with spade terminals drilled for terminating the number of conductors indicated on the Drawings, and the lugs that comply with requirements of Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- G. Capacities and Characteristics:

1. Taps: Comply with IEEE C57.12.26 requirements.
2. Transformer BIL (kV): Comply with IEEE C57.12.26 requirements.
3. Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

H. Transformer Accessories:

1. Drain and filter connection.
2. Filling and top filter press connections.
3. Pressure-vacuum gauge.
4. Dial-type analog thermometer with alarm contacts.
5. Magnetic liquid level indicator with high and low alarm contacts.
6. Automatically resetting pressure-relief device. Device flow shall be as recommended by manufacturer.
7. Stainless-steel ground connection pads.
8. Machine-engraved nameplate, made of anodized aluminum or stainless steel.

2.4 WARNING LABELS AND SIGNS

- A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
1. High-Voltage Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s). Sign legend shall be "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch-high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background.
 2. Arc Flash Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s), warning of potential electrical arc flash hazards and appropriate personal protective equipment required.

2.5 SOURCE QUALITY CONTROL

- A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.90.
1. Perform the following factory-certified routine tests on each transformer for this Project:
 - a. Resistance.
 - b. Turns ratio, polarity, and phase relation.
 - c. Transformer no-load losses and excitation current at 100 percent of ratings.
 - d. Transformer impedance voltage and load loss.
 - e. Operation of all devices.
 - f. Lightning impulse.
 - g. Low frequency.
 - h. Leak.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.
1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.
 2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
 3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.

4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on high- or low-voltage bushing parts, and at transformer base.
 5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
 6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
 7. Verify presence of polychlorinated biphenyl content labeling.
 8. Unload transformers carefully, observing all packing label warnings and handling instructions.
 9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
- B. Handling:
1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
 2. Protect transformer termination compartments against entrance of dust, rain, and snow.
 3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
 4. Verify that transformer weights are within rated capacity of handling equipment.
 5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
 6. Use jacks only at corners of tank base plate.
 7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
 8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
 9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.
- C. Storage:
1. Store transformers in accordance with manufacturer's recommendations.
 2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
 3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
 4. Store transformers with compartment doors closed.
 5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Verify that an effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.
- D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.
- E. Examine roughing-in of conduits and grounding systems to verify the following:
1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.
- F. Examine concrete bases for suitable conditions for transformer installation.

- G. Pre-Installation Checks:
1. Verify removal of any shipping bracing after placement.
 2. Remove a sample of insulating liquid according to ASTM D 923. Insulating-liquid values shall comply with NETA ATS, Table 100.4. Sample shall be tested for the following:
 - a. Dielectric Breakdown Voltage: ASTM D 877 or ASTM D 1816.
 - b. Acid Neutralization Number: ASTM D 974.
 - c. Interfacial Tension: ASTM D 971.
 - d. Color: ASTM D 1500.
 - e. Visual Condition: ASTM D 1524.
- H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.
- I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- B. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.
- C. Comply with requirements for vibration isolation and seismic control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and IEEE C2.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
 2. Make joints in grounding conductors and loops by exothermic weld or compression connector.
 3. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure.
 4. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
 2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.
- C. Terminate medium-voltage cables in incoming section of transformers according to Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

- A. Provide a UV stable engraved melamine nameplate mounted on the outside of the transformer, visible without opening the transformer doors, with the following information:
 - 1. Transformer name
 - 2. Transformer rating (kVA)
 - 3. Primary voltage
 - 4. Secondary voltage
 - 5. Impedance
 - 6. Source feeding the transformer
 - 7. Load name
- B. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
- C. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. General Field-Testing Requirements:
 - a. Comply with provisions of NFPA 70B Ch. "Testing and Test Methods."
 - b. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
 - c. After installing transformer but before primary is energized, verify that grounding system at the transformer is tested at specified value or less.
 - d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
 - e. Visual and Mechanical Inspection:
 - 1) Verify equipment nameplate data complies with Contract Documents.
 - 2) Inspect bolted electrical connections for high resistance using one of the following two methods:
 - a) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.
 - f. Remove and replace malfunctioning units and retest.
 - g. Prepare test and inspection reports. Record as-left set points of all adjustable devices.
 - 2. Liquid-Filled Transformer Field Tests:
 - a. Visual and Mechanical Inspection:
 - 1) Test dew point of tank gases if applicable.
 - 2) Inspect anchorage, alignment, and grounding.
 - 3) Verify bushings are clean.
 - 4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.

- 5) Verify that liquid level in tanks is within manufacturer's published tolerances.
- 6) Perform specific inspections and mechanical tests recommended by manufacturer.
- 7) Verify presence of transformer surge arresters and that their ratings are as specified.
- 8) Verify that as-left tap connections are as specified.

b. Electrical Tests:

- 1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.
- 2) Perform power-factor or dissipation-factor tests on all windings according to test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
- 3) Measure core insulation resistance at 500-V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.
- 4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 261219

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 4. Certification: Indicate that equipment meets Project seismic requirements.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. ABB.
 - 3. Hammond Power Solutions Inc.
 - 4. MGM Transformer Company.
 - 5. Siemens Power Transmission & Distribution, Inc.
 - 6. Square D; by Schneider Electric.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."

2.3 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
 - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.
 - 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 - 3. Grounded to enclosure.
- D. Coils: Continuous windings without splices except for taps.
 - 1. Coil Material: Copper.
 - 2. Internal Coil Connections: Brazed or pressure type.
 - 3. Terminal Connections: Bolted.
- E. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- F. Enclosure: Ventilated.
 - 1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 - 4. Finish: Comply with NEMA 250.
 - a. Finish Color: ANSI 49 gray weather-resistant enamel.
- G. Enclosure: Ventilated Totally enclosed, nonventilated.
 - 1. NEMA 250, Type 4X, Stainless Steel: Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
 - 2. Wiring Compartment: Sized for conduit entry and wiring installation.
- H. Taps for Transformers 3 kVA and Smaller: None.
- I. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- J. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- K. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- L. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- M. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- N. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
 2. Indicate value of K-factor on transformer nameplate.
 3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
- O. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 2. Include special terminal for grounding the shield.
- P. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.
- Q. Wall Brackets: Manufacturer's standard brackets.

2.5 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
 2. Ratio tests at rated voltage connections and at all tap connections.
 3. Phase relation and polarity tests at rated voltage connections.
 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 6. Applied and induced tensile tests.
 7. Regulation and efficiency at rated load and voltage.
 8. Insulation-Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
 - 2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Division 03 and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 - 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- F. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 - 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform power-factor or dissipation-factor tests on all windings.
 - d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - e. Perform an excitation-current test on each phase.
 - f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
 - g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- G. Remove and replace units that do not pass tests or inspections and retest as specified above.
- H. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.
 - 2. Surge protection devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Accessory components and features.
 - 6. Identification.
- B. Related Requirements
 - 1. Section 260573 "Power System Studies" for arc-flash analysis and arc-flash label requirements.

1.2 ACTION SUBMITTALS

- A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
 - 1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
- C. Delegated Design Submittal:
 - 1. For arc-flash hazard analysis.
 - 2. For arc-flash labels.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Routine maintenance requirements for switchboards and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
 4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
 5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
 6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and store in a way that prevents condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.8 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify **Construction Manager** no fewer than **seven** days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without **Owner's** written permission.
 - 4. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **Three** years from date of Substantial Completion.
- B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following:**
 1. Square D; by Schneider Electric.
 2. Eaton.
 3. SIEMENS Industry, Inc.; Energy Management Division.
 4. ABB.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 1. Main Devices: Fixed, individually mounted.
 2. Branch Devices: Panel mounted.
 3. Sections front and rear aligned.
- I. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- J. Indoor Enclosures: Steel, NEMA 250, Type 1.
- K. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- L. Outdoor Enclosures: Type 3R.
 1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
 2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
- M. Barriers: Between adjacent switchboard sections.
- N. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

- O. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 - 1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 - 2. Space-Heater Power Source: Transformer, factory installed in switchboard.
- P. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- Q. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- R. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- S. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- T. Pull Box on Top of Switchboard:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Set back from front to clear circuit-breaker removal mechanism.
 - 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 - 4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 - 5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- U. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 - 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated.
 - 3. Copper feeder circuit-breaker line connections.
 - 4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors.
 - 5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 6. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
 - 7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- V. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- W. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.3 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following:**
 - 1. Eaton.
 - 2. ABB.
 - 3. SIEMENS Industry, Inc.; Energy Management Division.
 - 4. Square D; by Schneider Electric.

- B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.

- C. Features and Accessories:
 - 1. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 2. Indicator light display for protection status.
 - 3. Form-C contacts 5 A and 250-V ac 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - 4. Surge counter.

- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
 - 1. Line to Neutral: 1200 V for 480Y/277 V.
 - 2. Line to Ground: 1200 V for 480Y/277 V.
 - 3. Line to Line: 2000 V for 480Y/277 V.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I squared t response.

 - 2. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - f. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

- g. Arc Energy Reducing Maintenance Switch: A dedicated switch for temporarily modifying the trip settings of the circuit breaker to reduce the available arc energy during maintenance. When activated, a blue LED shall be illuminated, with a permanently applied placard that reads "Maintenance Mode". Provide Maintenance Switch for all circuit breakers with frame ratings of 1200A or greater and for other devices as indicated on Drawings.

2.5 INSTRUMENTATION

- A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.6 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

2.8 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to **NEMA PB 2.1**.
 - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.

4. Install temporary heating during storage per manufacturer's instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to **NEMA PB 2.1**.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 3
 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to switchboards.
 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, surge protection devices, and instrumentation.
- H. Comply with NECA 1.

3.3 CONNECTIONS

- A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
- B. Support and secure conductors within the switchboard according to NFPA 70.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Test ground-fault protection of equipment for service equipment per NFPA 70.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 5. Perform the following infrared scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges per Section 260573 "Power System Studies".

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of NRTL listing for series rating of installed devices.
 - 7. Include evidence of NRTL listing for SPD as installed in panelboard.
 - 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 9. Include wiring diagrams for power, signal, and control wiring.
 - 10. Key interlock scheme drawing and sequence of operations.
 - 11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.

- B. Panelboard Schedules: For installation in panelboards.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and GFEP Types: Equal to 1 percent of quantity installed for each size and type, but no fewer than two of each size and type
Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; storage in a dry space with adequate heating to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

PART 2 - PRODUCTS

2.1 PANELBOARDS GENERAL REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and [Surface-mounted, as indicated, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. [Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Height: 84 inches maximum.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

G. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum for 400 Amp and below; Hard-drawn copper, 98 percent conductivity for 600 Amp and above.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
5. Split Bus: Vertical buses divided into individual vertical sections.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Same as buses.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have minimum short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical where supplied from transformers rated less than 75kVA and not less than 22,000 A rms symmetrical where supplied from transformers rated 112.5kVA or greater. Short-Circuit current rating shall be greater than the maximum available fault current as determined in the power system study specified in Section 260573 "Power System Studies".
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have minimum short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical. Short-Circuit current rating shall be greater than the maximum available fault current as determined in the power system study specified in Section 260573 "Power System Studies".

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD. Provide Type 1 for service entrance equipment; Type 2 for other panelboards as indicated or specified..

2.3 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. ABB.
 - 3. SIEMENS Industry, Inc.; Energy Management Division.
 - 4. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: As indicated.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker:[Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal or fused switches as indicated.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
 - 1. Eaton.
 - 2. ABB.
 - 3. SIEMENS Industry, Inc.; Energy Management Division.
 - 4. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: As indicated.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.
- G. Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension and overhead junction box equipped with ground and neutral terminal buses.
 - 1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.5 ELECTRONIC-GRADE PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following]:
 - 1. Eaton.
 - 2. ABB.
 - 3. SIEMENS Industry, Inc.; Energy Management Division.
 - 4. Square D; by Schneider Electric.

- B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. SPD.
 - 1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
 - 2. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - b. Line to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - c. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
 - d. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.
 - 3. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
 - a. Line to Neutral: 700 V.
 - b. Line to Ground: 700 V.
 - c. Neutral to Ground: 700 V.
 - d. Line to Line: 1200 V.
 - 4. SCCR: Equal to the SCCR of the panelboard in which installed.
 - 5. Inominal Rating: 20 kA.
- G. Buses:
 - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
 - 2. Copper equipment and isolated ground buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following
 - 1. Eaton.
 - 2. ABB.
 - 3. SIEMENS Industry, Inc.; Energy Management Division.
 - 4. Square D; by Schneider Electric.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.

- d. Multi-button keypad to access programmable functions and monitored data.
- e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
- f. Integral test jack for connection to portable test set or laptop computer.
- g. Field-Adjustable Settings:
 - 1) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "I" subscript on a circuit breaker:
 - a) Instantaneous trip.
 - 2) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "L" subscript on a circuit breaker:
 - a) Long-time pickup level.
 - b) Long-time time adjustment.
 - 3) For all circuit breakers with frame sizes equal to or greater than 400A or where specifically indicated on Drawings with "S" subscript on a circuit breaker:
 - a) Short-time pickup levels.
 - b) Short-time time adjustment.
 - 4) Where indicated on Drawings with "G" subscript on a circuit breaker or where required by NEC for circuit breakers with frame sizes rated 1000A and greater on 480V and 480Y/277V circuits:
 - a) Ground-fault pickup level, time delay, and I squared T response.
- 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
- 6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 - a. Provide AFCI circuit breakers for all 120V, 15A and 20A branch circuits serving the following areas:
 - 1) Dormitory Units:
 - a) Bedrooms
 - b) Living Rooms
 - c) Hallways
 - d) Closets
 - e) Bathrooms
 - f) Similar Rooms
 - 2) Other Occupancies
 - a) Patient sleeping rooms in nursing homes and limited care facilities
- 8. Subfeed Circuit Breakers: Vertically mounted.
- 9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

- h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
- i. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
- j. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
- k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- m. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
- n. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
- o. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position. Provide one for each branch circuit overcurrent device serving fire alarm equipment. Handle clamps installed for fire alarm overcurrent devices shall have a red finish.

2.7 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:
 - 1. Install power panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases in Division 3.
 - 2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
 - 3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.
- M. Install handle clamps on all branch circuit overcurrent devices serving fire alarm equipment.
- N. Stub three 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub three 1-inch empty conduits into raised floor space or below slab not on grade.
- O. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges per Coordination Study.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes electricity metering.

1.2 DEFINITIONS

- A. KY or KYZ Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity (kWh) that is based on a relay opening and closing in response to the rotation of the disk in the meter. Electronic meters generate pulses electronically.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of meter.
 - 2. For metering infrastructure components.
 - 3. For metering software.
- B. Shop Drawings: For electricity-metering equipment.
 - 1. Include elevation views of front panels of control and indicating devices and control stations.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
 - 4. Include series-combination rating data for modular meter centers with main disconnect device.
 - 5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that meters are compatible with connected monitoring and control devices and systems specified in Section 260913 "Electrical Power Monitoring and Control."
 - 1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
 - 2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.
- B. Qualification Data: For testing agency.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.
2. Software licenses.
3. Software service agreement.
4. Device address list.
5. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.
6. Meter data sheet for each meter, listing nameplate data and serial number, accuracy certification, and test results.
7. Meter installation and billing software startup report.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Owner shall be notified and issued written permission no fewer than two days in advance of proposed interruption of electrical service.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Damage from transient voltage surges.
 - b. .
 2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
 3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

1.9 COORDINATION

- A. Electrical Service Connections:
1. Coordinate with utility companies and utility-furnished components.
 - a. Comply with requirements of utility providing electrical power services.
 - b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 916.

2.2 UTILITY METERING INFRASTRUCTURE

- A. Install metering accessories furnished by the utility company, complying with its requirements.
- B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by the Utility.
 - 1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523 "Control-Voltage Electrical Power Cables."
- C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- D. Meter Sockets:
 - 1. Comply with requirements of electrical-power utility company.
 - 2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
- E. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only disconnect device, wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. General Electric Company.
 - c. SIEMENS Industry, Inc.; Energy Management Division.
 - d. Square D; by Schneider Electric.
 - 2. .Comply with requirements of utility company for meter center.
 - a. Comply with UL 67.
 - 3. Housing: NEMA 250, Type 1 Type 3R Type 4X enclosure.
 - 4. Meter Socket Rating: Coordinated with connected feeder circuit rating.
 - 5. Minimum Short-Circuit Rating: 22,000 42,000 65,000 100,000 Insert number A symmetrical at rated voltage.
 - 6. Steady-state and short-circuit current ratings shall have ratings that match connected circuit ratings.
 - 7. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers and having an adjustable magnetic trip setting for circuit-breaker frame sizes of 250 A and larger. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Circuit breakers shall be operable from outside the enclosure to disconnect the unit. Configure cover so it can be opened only when the disconnect switch is open.
 - 8. Main Disconnect Device: Fusible switch, UL 98 Type GD, series-combination rated by fuse manufacturer to protect downstream feeder and branch circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Switch shall be operable from outside the enclosure to disconnect the unit. Configure cover so that it can be opened only when the disconnect switch is open.
 - 9. Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect downstream circuit breakers and to house load centers and panelboards that have 10,000 Insert number-A interrupting capacity.
 - a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems."
 - b. Physical Protection: Tamper resistant, with hasp for padlock.
 - 10. Surge Protection for Main Disconnect: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 11. Surge Protection at Main Disconnect: Field-mounted external to the device, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 12. Surge Protection at Main Terminal Box: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

13. Surge Protection at Main Terminal Box: Field-mounted external to the device, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

F. Arc-Flash Warning Labels;

1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 260573.19 "Arc-Flash Studies." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
2. Labels: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
 - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1) Location designation.
 - 2) Nominal voltage.
 - 3) Flash protection boundary.
 - 4) Hazard risk category.
 - 5) Incident energy.
 - 6) Working distance.
 - 7) Engineering report number, revision number, and issue date.

2.3 ELECTRICITY METERS

- A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Davidge Controls.
 2. Eaton.
 3. E-Mon.
 4. General Electric Company.
 5. Leviton Manufacturing Co., Inc.
 6. National Meter Industries.
 7. Sensus Metering Systems.
 8. SIEMENS Industry, Inc.; Energy Management Division.
 9. Square D; by Schneider Electric.
 10. .
 11. Comply with ANSI C12.1 and ANSI C12.20, **0.2** accuracy class.
 12. Ambient Temperature: Minus 22 deg F to plus 158 deg F.
 13. Humidity: Zero to 95 percent, noncondensing.
 14. Capacities and Characteristics:
 - a. Circuit: 120/240-V ac, 100 A.
 - b. Measure: kWh, onboard LED display.
 - c. Remote-Reading Options: None.
- C. General Requirements for Meters:
 1. Billing Meters Accuracy: 0.2 0.5 1.0 percent of reading, complying with ANSI C12.20.
 2. Meters Certification: Certified by California Type Evaluation Program Insert agency as complying with 4 CCR 4027, Article 2.2 Insert state or Federal regulatory requirement.
 3. Certify that meters comply with ANSI C12.20 requirements by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The laboratory shall use test equipment that is certified annually and is traceable to NIST standards.

4. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 1 Type 3R Type 4X minimum, with provisions for locking or sealing.
 5. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
 6. Onboard Nonvolatile Data Storage: kWh, until reset.
 7. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
 - a. Type: Split and solid core, complying with recommendation of meter manufacturer.
- D. kWh Meter: Electronic single-phase and three-phase meters, measuring electricity use.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
 2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.
 3. Display: Digital electromechanical counter, indicating accumulative kWh.
- E. kWhd Meter: Electronic single-phase and three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute Insert time interval.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
 2. Display: LCD with characters not less than 0.25 inch high, indicating the following:
 - a. Accumulative kWh.
 - b. Current time and date.
 - c. Current demand.
 - d. Historic peak demand.
 - e. Time and date of historic peak demand.
 3. Retain accumulated kWh and historic peak demand in a nonvolatile memory, until reset.
- F. KY and KYZ Pulse Totalizer:
1. Pulse Totalizer: An instrument for demand and billing applications where one or more utility revenue meters stream KY or KYZ energy pulses. The instrument shall totalize kWh accumulated over the user-selected period and shall log the maximum and minimum kWhd for that period. Record each period with a date/time stamp. Time period shall be user selected from one to 60 minutes.
 - a. Pulse Input: One Insert number, individually programmable, KYZ Form C (three-wire) contact pulse channels. Pulse interval, pulse rate, and minimum pulse width shall be field adjustable, set for the pulse stream provided by the utility revenue meter.
 - b. Data Totalizing Capacity of Each Channel: Not less than 149 days at 15-minute intervals.
 - c. Instrument Power: User selectable, 120-V and 277-V ac.
 - d. Clock: Line frequency.
- G. Remote Reading Options:
1. Pulse Output: KY KYZ, complete with optical sensor and interface devices.
 2. Serial Interface: RS-232.
 3. Serial Interface: RS-485, with Modbus RTU protocol Insert protocol name.
 4. USB interface.
 5. TCP/IP adapter.
- H. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.
- I. Uninterruptible Power Supply: Single phase, 120-V ac, sized and rated to provide continuous power to meter for operations of 48 Insert number hours after interruption of normal power.
1. Output: Sine wave, total harmonic distortion less than 5 percent at full load.
 2. Battery: Maintenance free, sealed, lead acid, and leakproof.

3. Control Panel: LED status display of "on-battery," "replace battery," and "overload."
- J. Data Transmission Cable: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- K. Software: PC based, a product of recommended by meter manufacturer, suitable for calculating utility cost allocation.
 1. Utility Cost Allocation: Automatically import electricity-usage records to allocate electricity costs for the following:
 - a. At least 15 departments.
 - b. At least 30 tenants or activities.
 - c. At least five processes.
 - d. At least five buildings.
 - e.
 2. Activity Billing Software: Automatically import electricity-usage records to automatically compute and prepare electricity-use statements and invoices based on electricity use and peak demand. Maintain separate directory for each allocation. Prepare summary reports in user-defined formats and time intervals.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to switchboard installation requirements in NECA 400.
- D. Install arc-flash labels as required by NFPA 70.
- E. Wiring Method:
 1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
 3. Minimum conduit size shall be 1/2 inch.

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
 2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Equipment and Software Setup:
 - a. Set meter date and time clock.
 - b. Test, calibrate, and connect pulse metering system.
 - c. Set and verify billing demand interval for demand meters.
 - d. Report settings and calibration results.
 - e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.
 - 2. Connect a load of known kilowatt rating, **1.5 kW** minimum, to a circuit supplied by metered feeder.
 - 3. Turn off circuits supplied by metered feeder and secure them in off condition.
 - 4. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
 - 5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
 - 6. Generate test report and billing for each tenant or activity from the meter reading tests.
- F. Electricity metering will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.4 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's clerical and maintenance personnel to use, adjust, operate, and maintain the electronic metering and billing software.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.2 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
 - 2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two .

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1 and NEMA WD 6.
- E. Devices indicated as "tamper-resistant" shall have integral shutters that operate only when both prongs of a plug are inserted in the receptacle.
- F. Devices indicated as "weather-proof" or "weather-resistant" shall have the following:
 - 1. Spring-loaded, gasketed, "weather-proof-in-use" cover.
 - 2. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.
- G. Switches indicated as Key-switch shall have factory-supplied key in lieu of switch handle.
- H. Devices indicated or specified as anti-microbial shall have contact surfaces treated with a factory-applied coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.

- I. Devices indicated or specified as decorator style shall have a rectangular face opening.
- J. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- K. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Electrical System: Red.
 - 3. SPD Devices: Blue.
 - 4. Isolated-Ground Receptacles: Orange.
- L. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD RECEPTACLES, 125 V, 20 A

- A. Duplex Receptacles, 125 V, 20 A:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description: Two pole, three wire, and self-grounding.
 - 3. Configuration: Heavy-duty, NEMA 5-20R
 - 4. Standards: Comply with UL 498 and FS W-C-596.
- B. Isolated-Ground Duplex Receptacles, 125 V, 20 A:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
 - 3. Configuration: Heavy-duty, NEMA 5-20R
 - 4. Standards: Comply with UL 498 and FS W-C-596.

2.3 USB RECEPTACLES

- A. USB Charging Receptacles:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description:

- a. Receptacle: Duplex 20A, 125V receptacle, configuration 5-20R, with tamper-resistant shutters.
 - b. USB Ports: One USB Type A and one USB Type C port with total available charging current of 3.1A or greater at 5 VDC.
3. Standards: Comply with UL 498, UL 1310 and USB 3.0 devices.

2.4 GFCI RECEPTACLES, 125 V, 20 A

- A. Duplex GFCI Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/LeGrand (Pass & Seymour).
 2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
 3. Configuration: NEMA WD 6, Configuration 5-20R.
 4. Type: Non-feed through.
 5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.5 CONTROLLED RECEPTACLES, 125 V, 20 A

- A. Duplex Controlled Receptacle, 125 V, 20 A:
1. Description: Receptacle marked with the controlled receptacle symbol as required by NFPA 70 article 406.
 2. Configuration: Heavy-duty, NEMA WD 6, Configuration 5-20R.
 3. Receptacle Type: Standard, USB, GFCI, tamper-resistant, hospital-grade, or any combination thereof as required to meet the requirements of this Section pertaining to where specific receptacle types are required, or as specifically indicated on Drawings.
 4. Switching Configuration: Half-controlled or full controlled as indicated on Drawings.

2.6 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, amperage, voltage, and NEMA configuration as indicated on the Drawings: Comply with NEMA WD 1 and UL 498.
1. Products: Subject to compliance with the requirements, provide products by one of the following manufacturers:
 - a. Cooper
 - b. Hubbell
 - c. Leviton
 - d. Pass & Seymour

2.7 CORD AND PLUG SETS

- A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
- B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
- C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 TOGGLE SWITCHES, 120/277 V, 20 A

- A. Snap Switches, 120/277 V, 20 A :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 2. Standards: Comply with UL 20 and FS W-S-896.
- B. Pilot-Light, Snap Switches: 120/277 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 2. Description: Illuminated when switch is [on] [off].
 3. Standards: Comply with UL 20 and FS W-S-896.
- C. Lighted Snap Switches, 120/277 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Premise Wiring.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 2. Description: Handle illuminated when switch is [on] [off].
 3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.9 DIMMERS

- A. Wall-Box Dimmers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Lutron Electronics Co., Inc.
 - e. Pass & Seymour/Legrand (Pass & Seymour).
 2. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
 3. Control: Continuously adjustable slider; with single-pole or three-way switching.
 4. Standards: Comply with UL 1472.
 5. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.10 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting 0.035-inch-thick, satin-finished, Type 302 stainless steel. Material for Unfinished Spaces: Galvanized steel.
3. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.11 FLOOR SERVICE FITTINGS

- A. Flush-Type Floor Service Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Premise Wiring.
 - c. ABB (Electrification Products Division).
 - d. Wiremold / Legrand.
2. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
3. Compartments: Barrier separates power from voice and data communication cabling.
4. Service Plate and Cover: Rectangular, die-cast aluminum with satin finish.
5. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
6. Data Communication Outlet: Blank cover with bushed cable opening.

- B. Flap-Type Service Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Premise Wiring.
 - c. ABB (Electrification Products Division).
 - d. Wiremold / Legrand.
2. Description: Type: Modular, flap-type, dual-service units suitable for wiring method used, with flaps flush with finished floor.
3. Compartments: Barrier separates power from voice and data communication cabling.
4. Flaps: Rectangular die-cast aluminum with satin finish.
5. Service Plate: Same finish as flaps.
6. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
7. Data Communication Outlet: Blank cover with bushed cable opening.

- C. Above-Floor Service Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Premise Wiring.
 - c. ABB (Electrification Products Division).
 - d. Wiremold / Legrand.
2. Description: Type: Modular, above-floor, dual-service units suitable for wiring method used.
3. Compartments: Barrier separates power from voice and data communication cabling.
4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.12 Data Communication Outlet: Blank cover with bushed cable opening.FLOOR BOXES

- A. Description: Floor-mounted box with cover enclosing multiple outlets in a single assembly.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
 2. Wiremold; Legrand North America, LLC.
 3. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
- C. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- D. General Characteristics:
1. Reference Standards: UL 514A for metallic boxes; UL 514C for nonmetallic boxes, including scrub-water exclusion requirements; and UL 514D for cover plates.
 2. Provide separate paths for management of telecommunications and power cables in accordance with NFPA 76.
 3. Compartments: Barrier separates power from voice and data communication cabling.
 4. Concrete Floor Boxes:
 - a. Provide floor boxes classified for use in fire rated concrete floors. Match floor box fire rating to floor assembly. Boxes indicated in floors in contact with the earth must be protected by epoxy paint or must be made of a suitable material to prevent oxidation and deterioration such as cast iron.
 - b. Floor boxes must provide a minimum of four inches of adjustment prior to concrete pour and a minimum of 1/2 inch after concrete is set.
- E. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.
- F. Floor Box Type FB1:
1. Description: Recessed 2-compartment power floor box.
 - a. Compartment 1: 20-ampere, 125-volt duplex receptacle.
 - b. Compartment 2: 20-ampere, 125-volt duplex receptacle.
- G. Floor Box Type FB2:
1. Description: Recessed 4-compartment power and telecommunications floor box
 - a. Compartment 1: 20-ampere, 125-volt duplex receptacle.
 - b. Compartment 2: 20-ampere, 125-volt duplex receptacle.
 - c. Compartment 3: Communication bracket with four knockouts which accept standard RJ type keystone jacks.
- H. Floor Box Type FB3:
1. Description: Recessed 6-compartment power/telecommunications/AV floor box.
 - a. Compartment 1: 20-ampere, 125-volt duplex receptacle.
 - b. Compartment 2: 20-ampere, 125-volt duplex receptacle.
 - c. Compartment 3: Communication bracket with four knockouts which accept standard RJ type keystone jacks.
- I. Covers: Flanged cover for use in tile or carpet, with brushed cable pass-through.
1. Finish: Black.
- 2.13 POKE-THRU ASSEMBLIES**
- A. Description: Factory-fabricated assembly of below-floor junction box with multichannel, through-floor raceway/firestop unit with receptacles or communications outlets installed below floor surface level.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB (Electrification Products Division).
 2. Wiremold; Legrand North America, LLC.
 3. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
- C. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- D. General Characteristics:
1. Reference Standards: UL 514A for metallic boxes and UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.
 2. Provide separate paths for management of telecommunications and power cables.
 3. Fire Rating: Provide unit listed and labeled for fire rating of floor-ceiling assembly.
- E. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.
- F. Poke-Through Type PT1:
1. Service Outlet Assembly: Flush type with two simplex receptacles.
 2. Core Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
- G. Poke-Through Type PT2:
1. Service Outlet Assembly: Recessed type with two 20-ampere, 125-volt duplex receptacles and a modular low voltage section capable of accepting low voltage connectors. Provide RJ-45 jack quantities as required to accommodate the quantity of data cables indicated on the Drawings. Where specific data cable quantities are not indicated, provide two RJ-45 connectors.
 2. Core size: Selected to fit nominal 6-inch cored holes in floor and matched to floor thickness.
- H. Poke-Through Type PT3:
1. Service Outlet Assembly: Flush type with connectors for flexible conduit connections for power and telecommunications service to furniture systems.
- I. Covers: Flanged for use in tile or carpet.
1. Finish: As Selected by Architect.

2.14 SURFACE RACEWAYS

- A. Description: Two-piece, aluminum construction multioutlet assembly with brushed natural or satin anodized natural finish with devices, junction fittings, and other matching accessories as required for a complete system and per UL 5.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Wiremold / Legrand.
 3. MonoSystems, Inc.
- C. General:
1. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
 2. Provide continuous one-piece cover plates, minimum four feet long.
 3. Provide GFCI receptacles for sections of multioutlet assemblies that are indicated within 6'-0" of the edge of a sink.
 4. Wiring: Minimum no. 12 AWG solid, Type THHN copper. Provide larger conductor sizes where receptacles with ampacities greater than 20-amperes are indicated.

- D. Surface Raceway Type SR-1
 - 1. Multioutlet assembly with prewired, 20-ampere, 125-volt, 2-pole, 3-wire duplex receptacles on 18-inch centers, alternately connected to one 20-ampere circuits, 120-volt circuits with ground.
 - 2. Receptacle Finish: Grey

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Type:
 - 1. Install GFCI receptacles for all receptacles supplied by single-phase branch circuits rated 150V or less to ground in the following spaces/locations:
 - a. Bathrooms.
 - b. Kitchens or similar areas with a sink and permanent provisions for either food preparation or cooking.

- c. Buffet serving areas with permanent provisions for food serving, beverage serving, or cooking.
 - d. Where the receptacle is installed within 6 feet of the edge of a sink.
 - e. Outdoors.
 - f. Indoor damp and wet locations.
 - g. Locker rooms with associated showering facilities.
 - h. Garages, accessory buildings, service bays, and similar areas.
 - i. Laundry areas.
2. Install GFCI receptacles at the following equipment supplied by single-phase branch circuits rated 150V or less to ground and 60 amperes:
- a. Automotive vacuum machines
 - b. Drinking water coolers and bottle fill stations
 - c. High-pressure spray washing machines
 - d. Tire inflation machines
 - e. Vending machines
 - f. Sump pumps
 - g. Dishwashers
 - h. Electric Ranges
 - i. Wall-mounted ovens
 - j. Counter-mounted cooking units
 - k. Clothes dryers
 - l. Microwave ovens
3. Where GFCI receptacles cannot be installed in a readily accessible location or are not available in the receptacle configuration required to serve a specific load, provide equivalent ground fault circuit interrupter protection by installing a GFCI type circuit breaker as the branch circuit overcurrent protective device for the load.
4. Install tamper-resistant versions of the specified receptacles for all 20A, 125V and 250V nonlocking-type receptacles in the following areas:
- a. All spaces in educational facilities.
 - b. Business offices, corridors, waiting rooms, and similar spaces in clinics, medical and dental offices, and outpatient healthcare facilities.
 - c. Dormitory units.
 - d. Gymnasiums.
 - e. Auditoriums.
 - f. All spaces in assisted living facilities.
- F. Receptacle Orientation:
- 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- H. Dimmers:
- 1. Install dimmers within terms of their listing.
 - 2. Verify that dimmers used for fan-speed control are listed for that application.
 - 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.
- I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- J. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

- K. Floor boxes and poke-thru assemblies: For each floor box and poke-thru with communications devices or provisions, provide a conduit stubbed into the accessible ceiling space above the room served by the floor mounted device. Stubbing conduits into the ceiling space below is not permitted.

3.2 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each wiring device with panelboard identification and circuit number. In spaces where low voltage lighting control wall stations are utilized, identify panelboard and circuit number of the lights controlled by the low voltage device. In spaces with multiple lighting circuits, provide multiple tables to indicate each lighting branch circuit serving the space. Use hot, stamped, or engraved machine printing with black-filled lettering on front face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Tests for Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Enclosed switches.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

1.3 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Bussmann, an Eaton business.
 - 2. Edison; a brand of Bussmann by Eaton.
 - 3. Littelfuse, Inc.
 - 4. Mersen USA.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 - 1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 - 2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 - 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, time delay.
 - 4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, time delay.
 - 5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 - 6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.

- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Construction Manager.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
- C. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

- D. Comply with NFPA 70.

2.3 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
 2. ABB.
 3. Siemens Industry, Inc.
 4. Square D; by Schneider Electric.
- B. Type HD, Heavy Duty:
1. Single throw.
 2. Three pole, unless otherwise indicated.
 3. 240 or 600-V ac.
 4. Ampacity as indicated or scheduled.
 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified or indicated fuses.
 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 5. Arc-Energy Reduction Relay: For switches rated 1200A, provide internally mounted device compliant with NFPA 70 article 240.67 requirements, with external display containing pushbutton and visual indicator for maintenance mode.
 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 8. Service-Rated Switches: Labeled for use as service equipment.

2.4 RECEPTACLE SWITCHES

- A. Same as specified for fusible and nonfusible switches plus the following:
1. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
 2. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] :
1. Eaton.
 2. ABB.
 3. Siemens Industry, Inc.
 4. Square D; by Schneider Electric.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. Fuse/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. _____ Amps Available. Identical Replacement Component Required."
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.
- G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 4. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 5. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
 - 6. Arc-Energy Reduction: For circuit breakers rated 1200A or greater, provide circuit breaker compliant with NFPA 70 article 240.87 requirements, with external display containing pushbutton and visual indicator for maintenance mode.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1); gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12); a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel); copper-free cast aluminum alloy (NEMA 250 Types 7, 9).

- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be [directly operable through the front cover of the enclosure (NEMA 250 Type 1); directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R); externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.2 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.
- G. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Power System Studies."
- H. Where motor disconnect switches are installed downstream of a variable frequency drive (VFD), provide 2#12 AWG conductors from the disconnect switch to the VFD. Terminate wiring in disconnect switch at early break auxiliary contacts and coordinate programming and terminating of conductors at VFD with VFD installer.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform tests and inspections.
- D. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
 - 2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- E. Tests and Inspections for Molded Case Circuit Breakers:
- 1. Visual and Mechanical Inspection:
 - a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with the coordination study.
 - 2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Prepare test and inspection reports.
- 1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

- A. CE: Conformance Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. LED: Light-emitting diode.
- F. NC: Normally closed.
- G. NO: Normally open.
- H. OCPD: Overcurrent protective device.
- I. PID: Control action, proportional plus integral plus derivative.
- J. RFI: Radio-frequency interference.
- K. VFC: Variable-frequency motor controller, also known as Variable frequency drive (VFD)

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
 - 1. Include dimensions and finishes for VFCs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each VFC indicated.
 - 1. Include mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Required working clearances and required area above and around VFCs.
 - 2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
 - 3. Show support locations, type of support, and weight on each support.

4. Indicate field measurements.
- B. Qualification Data: For testing agency.
- C. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.
 1. Certificate of compliance.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.
- D. Product Certificates: For each VFC from manufacturer.
- E. Field quality-control reports.
- F. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
 - b. Manufacturer's written instructions for setting field-adjustable overload relays.
 - c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 3. Indicating Lights: Two of each type and color installed.
 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. ABB Low Voltage HVAC Drives.
 - 2. Danfoss Inc.
 - 3. Eaton.
 - 4. SIEMENS Industry, Inc.; Energy Management Division.
 - 5. Yaskawa Electric America, Inc.
 - 6. Or equal.

2.2 SYSTEM DESCRIPTION

- A. General Requirements for VFCs:
 - 1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 61800-5-1.
- B. Application: variable torque.
- C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 - 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 - 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
 - 2. Input AC Voltage Unbalance: Not exceeding 3 percent.

3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
 7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
 8. Humidity Rating: Less than 95 percent (noncondensing).
 9. Altitude Rating: Not exceeding 3300 feet.
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 13. Speed Regulation: Plus or minus 5 percent.
 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
 2. Surge Suppression: Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.
 3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 4. Under- and overvoltage trips.
 5. Inverter overcurrent trips.
 6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
 7. Critical frequency rejection, with [three] <Insert number> selectable, adjustable deadbands.
 8. Instantaneous line-to-line and line-to-ground overcurrent trips.
 9. Loss-of-phase protection.
 10. Reverse-phase protection.
 11. Short-circuit protection.
 12. Motor-overtemperature fault.
- K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Integral Input Disconnecting Means and OCPD: [UL 489, instantaneous-trip circuit breaker] [UL 489, molded-case switch, with power fuse block and current-limiting fuses] [UL 489, thermal-magnetic circuit breaker] [NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses] [NEMA KS 1, fusible switch] with pad-lockable, door-mounted handle mechanism.
 - 1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
 - 2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 - 3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
 - 4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 - 5. [NC] [NO] alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

2.4 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 - 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).

4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 0- to 10-V dc
 - b. A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of one programmable analog output signal(s) 0- to 10-V dc, which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).
4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.

F. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.

1. Hardwired Points:
 - a. Monitoring: On-off status.
 - b. Control: On-off operation.
2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

- A. Output Filtering:.
- B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.
- C. EMI/RFI Filtering:.

2.6 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: Type 3R.

2.7 ACCESSORIES

- A. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- B. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- C. Spare control-wiring terminal blocks[; unwired]; wired].

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
 - 1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
 - 2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."
- C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible-switch VFC.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- I. Comply with NECA 1.

3.2 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices **and facility's central-control system**. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.3 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFC with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set the taps on reduced-voltage autotransformer controllers.
- C. Set field-adjustable circuit-breaker trip ranges **as specified in Section 260573.16 "Coordination Studies."**
- D. Set field-adjustable pressure switches.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged engine-generator sets for **emergency andstandby** power supply with the features as specified and indicated.
- B. Related Sections include the following:
 - 1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.2 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Compliance Statement
 - 1. Submit a document which states whether the proposed product(s) either comply or deviate from the Specification requirements. This includes all Part 1, Part 2, and Part 3 specification items. Specification requirements not noted as deviations will be assumed as complying.
 - 2. Provide the statement in an itemized, columnar format as follows:
 - a. Column 1 - Reference to the specification item, organized in the same sequential order as in the Specification.
 - b. Column 2 - Explanation for noted deviations.
- D. Manufacturer Seismic Qualification Certification: Submit certification that **day tank**, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

- b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Qualification Data: For .
- F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
- 1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- 1. Maintenance Proximity: Not more than 200 miles (321 km) from Installer's place of business to Project site.
 - 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 99.
- I. Comply with NFPA 110 requirements for Level 1 2 emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Architect Construction Manager Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: 5 to 40 deg C.
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 1000 feet (300 m).

- C. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:
 - 1. .

1.6 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators and remote radiators mounted on grade. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

- B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Division 07 Section "Roof Accessories."

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Date of Acceptance, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar; Engine Div.
 2. Generac Power Systems, Inc.
 3. Kohler Energy
 4. Onan/Cummins Power Generation; Industrial Business Group.
 5. MTU Onsite Energy Corporation.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:
1. Power Output Ratings: Continuous electrical output power rating for standby operation of not less than 500kW, at 80 percent lagging power factor, 480/277 -volt, three phase, 4-wire, 60 hertz. In addition, provide power required for generator accessories including battery charger and radiator.
 2. Provide generator with a minimum motor starting capability of 300SkVA and capable of sustaining a minimum of 90 percent of rated no-load voltage with the specified kVA load at near zero power factor applied to the generator.
 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator-Set Performance:
1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 8. Start Time: Comply with NFPA 110, Type 10, system requirements.
- E. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Fuel: Fuel oil, Grade DF-2 Natural gas with automatic LP-gas standby Natural gas.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.
- D. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

Generator Size

Heater Voltage

0-400 kW	120 or 208 single phase
400-800 kW	208 or 480 single phase
Above 800 kW	480 single phase

1. Suitable for operation on **120**-volt, single phase, 60 hertz power.
- G. Governor: Adjustable isochronous, with speed sensing.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
1. Configuration: **Vertical** air discharge.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 4. Fan: Driven by **multiple belts from engine shaft**Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- J. Muffler/Silencer: Industrial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Minimum sound attenuation of 12 dB at 500 Hz.
 2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 70 dBA or less.
- K. Air-Intake Filter: **Standard**, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- L. Starting System: 1 **2**-V electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.

4. Battery: Lead-acid adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least **twice** without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
 1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
 - a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
 2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine-generator system without being refilled.
 3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
 4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
 5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
 6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
 7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.
- C. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
 1. Tank level indicator.
 2. Capacity: Fuel for 24 hours' continuous operation at 100 percent rated power output.

3. Vandal-resistant fill cap.
 4. Containment Provisions: Comply with requirements of authorities having jurisdiction.
- D. Fuel Oil Tank Alarm Panel: Weatherproof enclosure with the following features:
1. Low level alarm.
 2. High level alarm.
 3. Critical high level alarm.
 4. Fuel tank leak alarm.
 5. Alarm horn.
 6. Silence button.
- E. Fuel Oil
1. Fill storage tanks with fuel oil prior to Acceptance Testing and replenish spent fuel after Owner Acceptance.

2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
1. Engine start circuits from emergency and fire pump transfer switches shall be monitored for broken, shorted , or disconnected wires as required by NFPA 70 articles 695 and 700. Loss of start circuit wiring shall start the generator. Provide all control wiring and hardware required to provide engine start circuit integrity monitoring as required by the referenced code articles.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 2 system, and the following:
1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.
 8. Ammeter-voltmeter, phase-selector switch(es).
 9. Generator-voltage adjusting rheostat.
 10. Fuel tank derangement alarm.
 11. Fuel tank high-level shutdown of fuel supply alarm.
 12. Generator overload.
- D. Indicating and Protective Devices and Controls:
1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.

8. Ammeter-voltmeter, phase-selector switch(es).
 9. Generator-voltage adjusting rheostat.
 10. Start-stop switch.
 11. Overspeed shutdown device.
 12. Coolant high-temperature shutdown device.
 13. Coolant low-level shutdown device.
 14. Oil low-pressure shutdown device.
 15. Fuel tank derangement alarm.
 16. Fuel tank high-level shutdown of fuel supply alarm.
 17. Generator overload.
- E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."
- G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
 2. Coolant low-temperature alarm.
 3. Control switch not in auto position.
 4. Battery-charger malfunction alarm.
 5. Battery low-voltage alarm.
- H. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
1. Engine high-temperature shutdown.
 2. Lube-oil, low-pressure shutdown.
 3. Overspeed shutdown.
 4. Remote emergency-stop shutdown.
 5. Engine high-temperature prealarm.
 6. Lube-oil, low-pressure prealarm.
 7. Fuel tank, low-fuel level.
 8. Low coolant level.
- I. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
 2. Trip Rating: Matched to generator rating.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4. Mounting: Adjacent to or integrated with control and monitoring panel.
 5. Main circuit breaker UL-listed as service-entrance equipment.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Dripproof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12 percent, maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments, control, day tank and battery system shall be mounted within enclosure.
1. Provide enclosure which maintains a minimum interior ambient temperature of 40 degrees F. per NFPA 110.
- B. Description: Prefabricated or preengineered walk-in enclosure with the following features:
1. Provide enclosure which maintains a minimum interior ambient temperature of 40 degrees F per NFPA 110.
 2. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
 3. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
 4. Space Heater: Thermostatically controlled and sized to prevent condensation.
 5. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
 6. Hinged Doors: With padlocking provisions.
 7. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
 8. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components and NFPA 110.
 9. Muffler Location: Within enclosure.
 10. Access Stairs and Platforms: Provide where indicated on Drawings or if required by governing codes to provide access to overcurrent protective devices.
- C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- D. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
1. AC lighting system and connection point for operation when remote source is available.
 2. DC lighting system for operation when remote source and generator are both unavailable.
- E. Convenience Outlets: Factory wired , **GFCI**. Arrange for external electrical connection.
- F. Load Center: Provide a 208Y/120V, 3 Phase, 4 Wire, 100A MCB (main circuit breaker) type panelboard within the enclosure for power service to generator accessories including but not limited to: battery charger, jacket water heaters, lights, receptacles, enclosure heater, and motorized dampers. Generator accessories shall be factory wired to the panelboard. All internal wiring shall be type THHN/THWN-2 in EMT in accordance with all governing codes. If load center is located near the air intake louver and will be subject to moisture from rain or snow, provide a NEMA 3R enclosure.

2.9 LOAD BANK CONNECTION BOX

- A. Weather-resistant enclosure, permanently wired to the generator to permit the connection of a portable load bank. The load bank connection box shall have the following features:

1. Housing: Aluminum, NEMA 3R
2. Rating: 800A
3. Permanent Bus Connection: Mechanical Lugs
4. Load bank connection: Female Cam style receptacles, color coded for the voltage system.
5. Accessories: Phase Rotation Monitor

2.10 MOTORS

- A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.11 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
1. Material: Bridge-bearing neoprene, complying with AASHTO M 251.
 2. Durometer Rating: 30.
 3. Number of Layers: Four Insert number.
- B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.12 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer. Outdoor enclosure finish color shall be selected by Architect.

2.13 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 2. Full load run.
 3. Maximum power.
 4. Voltage regulation.

5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with vibration isolation devices as specified having a minimum deflection of 1 inch. Insert static deflection on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Install remote radiator with vibration isolation devices as specified having a minimum deflection of 1 inch (25 mm) on concrete base on grade.
- E. Install Schedule 40, black steel piping with welded joints for cooling water piping between engine-generator set and remote radiator. Piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
- F. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
 1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
- G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect cooling-system water piping to engine-generator set and remote radiator with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Connect fuel piping to engines with a gate valve and union and flexible connector.
 - 1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Division 23 Section "Facility Fuel-Oil Piping."
 - 2. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Facility Natural-Gas Piping."
 - 3. LP-gas piping, valves, and specialties for gas piping are specified in Division 23 Section "Facility Liquefied-Petroleum Gas Piping."
- F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- G. Connect power wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- H. Provide engine start wiring from generator controller to transfer switches. Engine start wiring shall be type and size as recommended by manufacturer. Where manufacturer does not have a specific recommendation, provide #12 AWG THHN/THWN-2 conductors.
 - 1. Route engine start wiring in separate raceways and entirely independent from all wiring
 - 2. Coordinate engine start signal wiring installation with transfer switch manufacturer and installer. For emergency and fire pump transfer switches, ensure proper connection and operation of the engine start circuit integrity monitoring required by NFPA 70 articles 695 and 700.
- I. Provide power and communications wiring for remote generator annunciator (derangement) panel. Provide wiring type and size as recommended by manufacturer.
 - 1. Where generator annunciator panel location is not specifically indicated on Drawings, coordinate exact location with Owner prior to installation.

3.4 IDENTIFICATION

- A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

- b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
- 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 - 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 - 7. Exhaust Emissions Test: Comply with applicable government test criteria.
 - 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 - 9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 - 10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
 - D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
 - E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - H. Remove and replace malfunctioning units and retest and reinspect as specified above.
 - I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
 - J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Coordination of Submittals: Include preliminary power system studies with submittal or submit to Architect prior to submittal. Refer to Section 260573 "Power System Studies" for additional requirements. Transfer switches submitted prior to preliminary power system studies will be returned without review.
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Include material lists for each switch specified.
 - 3. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 - 4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **manufacturer-authorized service representative**.
- B. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Features and operating sequences, both automatic and manual.
 - b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications:

1. Member company of NETA.
 - a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 99.
- D. Comply with NFPA 110.
- E. Comply with UL 1008 unless requirements of these Specifications are stricter.
- F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
 2. Short-time withstand capability for **3** cycles.
- H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- K. Service-Rated Transfer Switch:
 1. Comply with UL 869A and UL 489.
 2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
 3. In systems with a neutral, the bonding connection shall be on the neutral bus.
 4. Provide removable link for temporary separation of the service and load grounded conductors.
 5. Surge Protective Device: Service rated.

6. Ground-Fault Protection: Comply with UL 1008 for normal bus.
7. Service Disconnecting Means: Externally operated, manual electrically actuated.

- L. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

- M. Neutral Terminal: Solid and fully rated unless otherwise indicated.

- N. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

- O. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

- P. Battery Charger: For generator starting batteries.
 1. Float type, rated **2** A.
 2. Ammeter to display charging current.
 3. Fused ac inputs and dc outputs.

- Q. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

- R. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
 4. Accessible via **rear** access.

- S. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Caterpillar, Inc.; Electric Power Division.
 2. Cummins Power Generation.
 3. Eaton.
 4. ASCO Power Technologies.
 5. Generac Power Systems, Inc.
 6. MTU Onsite Energy Corporation.
 7. Russelectric, Inc.
 8. ABB.

- B. Comply with Level 1 equipment according to NFPA 110.

- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
 2. Switch Action: Double throw; mechanically held in both directions.
 3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.

4. Conductor Connectors: Suitable for use with conductor material and sizes.
 5. Material: Tin-plated aluminum Hard-drawn copper, 98 percent conductivity.
 6. Main and Neutral Lugs: Compression Mechanical type.
 7. Ground Lugs and Bus-Configured Terminators: Compression Mechanical type.
 8. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- E. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- G. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- H. Automatic Transfer-Switch Controller Features:
1. Controller operates through a period of loss of control power.
 2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 5. Test Switch: Simulate normal-source failure.
 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
 11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
 12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

- a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is unavailable.
- I. Large-Motor-Load Power Transfer:
1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
 2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
 3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 MOLDED-CASE-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar, Inc.; Electric Power Division.
 2. Cummins Power Generation.
 3. Eaton.
 4. ABB.
 5. Generac Power Systems, Inc.
- B. Comply with Level 1 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using contactor-based components are unacceptable.
 2. Switch Action: Double throw; mechanically held in both directions.
 3. Contacts: Silver composition or silver alloy for load-current switching.
 4. Conductor Connectors: Suitable for use with conductor material and sizes.
 5. Material: Tin-plated aluminum Hard-drawn copper, 98 percent conductivity.
 6. Main and Neutral Lugs: Compression Mechanical type.
 7. Ground Lugs and Bus-Configured Terminators: Compression Mechanical type.
 8. Ground bar.
 9. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- E. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

- F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- G. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- H. Transfer Switches Based on Molded-Case-Switch Components: Comply with UL 489 and UL 869A.
- I. Automatic Transfer-Switch Controller Features:
 - 1. Controller operates through a period of loss of control power.
 - 2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 - 4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 - 5. Test Switch: Simulate normal-source failure.
 - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
 - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 - 9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
 - 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
 - 11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
 - 12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
 - 13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is unavailable.
- J. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.4 NONAUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ASCO Power Technologies.
 2. Caterpillar, Inc.; Electric Power Division.
 3. Eaton.
 4. ESL Power Systems, Inc.
 5. Russelectric, Inc.
- B. Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
- C. Manual and Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.
- D. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.
- E. Pilot Lights: Indicate source to which load is connected.
- F. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.
 1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 2. Emergency Power Supervision: Red light with nameplate engraved "Alternative Source Available."
- G. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac.
- H. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 1. Switch Action: Double throw; mechanically held in both directions.
 2. Contacts: Silver composition or silver alloy for load-current switching.
 3. Conductor Connectors: Suitable for use with conductor material and sizes.
 4. Material: Tin-plated aluminum Hard-drawn copper, 98 percent conductivity.
 5. Main and Neutral Lugs: Compression Mechanical type.

6. Ground Lugs and Bus-Configured Terminators: Compression Mechanical type.
7. Connectors shall be marked for conductor size and type according to UL 1008.

2.5 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
 - a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
 - b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
 - c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
 - d. Transition: Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
 - e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
 - f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
 - g. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
 - h. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
 - i. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciator panel display shall include the following indicators:
 - a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - b. Switch position.
 - c. Switch in test mode.
 - d. Failure of communication link.
4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
 - a. Indicating Lights: Grouped for each transfer switch monitored.
 - b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
 - c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
 - d. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Remote Annunciator and Control System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:
 - a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - b. Indication of switch position.
 - c. Indication of switch in test mode.
 - d. Indication of failure of digital communication link.
 - e. Key-switch or user-code access to control functions of panel.
 - f. Control of switch-test initiation.
 - g. Control of switch operation in either direction.
 - h. Control of time-delay bypass for transfer to normal source.
3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
 - a. Controls and indicating lights grouped together for each transfer switch.
 - b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
 - c. Digital Communication Capability: Matched to that of transfer switches supervised.
 - d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

D. Digital Power Meter

1. Mounting: Flush in front door of transfer switch
2. Display: Digital LCD
3. Metered Parameters:
 - a. LL/LN Voltage
 - b. A,B,C, N Currents
 - c. Power (kW, kVA, kVAR)
 - d. Power Factor
 - e. Frequency
 - f. kW Demand
 - g. Accumulated Energy (kWh, kVAh, kVARh)
 - h. Total Harmonic Distortion (THD)
 - i. Min/max historical values
4. Accuracy:
 - a. Current, Voltage, Power, Frequency: 1.0%
 - b. Energy, Power Factor, Demand: 1.0%
5. Displaying of each of the metered quantities shall be accomplished through the use of menu scroll buttons.
6. Reset of stored historical values and accumulated values shall be performed through the local access display. All reset functions shall have a means for protection against unauthorized/accidental changes.
7. Provide current transformers as required to provide specified metering functions and accuracy.

2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

- B. Prepare test and inspection reports.
 - 1. For each of the tests required by UL 1008, performed on representative devices, for **emergency** systems. Include results of test for the following conditions:
 - a. Overvoltage.
 - b. Undervoltage.
 - c. Loss of supply voltage.
 - d. Reduction of supply voltage.
 - e. Alternative supply voltage or frequency is at minimum acceptable values.
 - f. Temperature rise.
 - g. Dielectric voltage-withstand; before and after short-circuit test.
 - h. Overload.
 - i. Contact opening.
 - j. Endurance.
 - k. Short circuit.
 - l. Short-time current capability.
 - m. Receptacle withstand capability.
 - n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
 - 3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
 - 4. Provide workspace and clearances required by NFPA 70.
- B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
- C. Identify components according to Section 260553 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
 - 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- F. Connect twisted pair cable according to Section 260513 "Low-Voltage Electrical Power Conductors and Cables."
- G. Connect twisted pair cable according to manufacturer's installation instructions.
- H. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.
- I. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."
- J. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify that the unit is clean.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Verify that manual transfer warnings are attached and visible.
 - g. Verify tightness of all control connections.
 - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
 - i. Perform manual transfer operation.
 - j. Verify positive mechanical interlocking between normal and alternate sources.
 - k. Perform visual and mechanical inspection of surge arresters.
 - l. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
 - 3. Electrical Tests:
 - a. Perform insulation-resistance tests on all control wiring with respect to ground.
 - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
 - c. Verify settings and operation of control devices.
 - d. Calibrate and set all relays and timers.
 - e. Verify phase rotation, phasing, and synchronized operation.
 - f. Perform automatic transfer tests.

- g. Verify correct operation and timing of the following functions:
 - 1) Normal source voltage-sensing and frequency-sensing relays.
 - 2) Engine start sequence.
 - 3) Time delay on transfer.
 - 4) Alternative source voltage-sensing and frequency-sensing relays.
 - 5) Automatic transfer operation.
 - 6) Interlocks and limit switch function.
 - 7) Time delay and retransfer on normal power restoration.
 - 8) Engine cool-down and shutdown feature.
 - 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 - 5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 - 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
 - D. Coordinate tests with tests of generator and run them concurrently.
 - E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
 - F. Transfer switches will be considered defective if they do not pass tests and inspections.
 - G. Remove and replace malfunctioning units and retest as specified above.
 - H. Prepare test and inspection reports.
- 3.4 DEMONSTRATION**
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
 - B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

- C. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 263650 - GENERATOR DOCKING STATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes generator docking stations (also referred to as quick-connect panels) rated 600V and less.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Include material lists for each switch specified.
 - 3. Single-Line Diagram: Show connections between permanent generator, temporary generator, automatic transfer switch. Show interlocking provisions as specified.
 - 4. Riser Diagram: Show interconnection wiring between docking station, remote transfer switches, power sources, power distribution equipment, remote start contacts, remote alarm and control panels.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer-authorized service representative
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operations and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Comply with NFPA 110.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

- A. The equipment installed under this contract shall be left in proper working order.

- B. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 - PRODUCTS

2.1 GENERATOR DOCKING STATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trystar
 - 2. Powertron
 - 3. ASCO
 - 4. Eaton
 - 5. ESL Power Systems

2.2 GENERAL REQUIREMENTS

- A. Docking station shall include 16 Series Camlok Panel Mounts for use as connection to Portable Generator and/or Temporary Load Bank as indicated on Drawings.
- B. Entire package must be listed to ETL or UL 1008 Standards. UL listing of individual components is not acceptable.
- C. Enclosures:
 - 1. NEMA 3R4X enclosure.
 - a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of cables from portable generator or portable load bank. NEMA integrity shall be maintained with access plate open for cable entry.
 - b. Front and side through a front access panel shall be accessible for maintenance.
 - c. Top, side, and bottom through a front access panel shall be accessible for permanent cabling.
 - 2. Finishes:
 - a. Paint after fabrication. Powder coated manufacturer's standard greycustom color to be selected by Architect.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated or Silver-plated Copper
 - 2. Equipment Ground Bus: bonded to box.
 - 3. Ground Bus: 50% of phase size.
 - 4. Neutral Bus: Neutral bus rated 100 percent of phase bus.
- E. Temporary generator connectors shall be Camlok style mounted on gland plate.
 - 1. Camlok shall be color coded according to system voltage
 - a. A phase: Black (208/120V) or Brown (480/277V)
 - b. B phase: Red (208/120V) or Orange (480/277V)
 - c. C phase: Blue (208/120V) or Yellow (480/277V)
 - d. N Neutral: White
 - e. G Ground: Green
- F. Temporary load bank connectors shall be Camlok style mounted on gland plate.
 - 1. Camlok shall be color coded according to system voltage
 - a. A phase: Black (208/120V) or Brown (480/277V)
 - b. B phase: Red (208/120V) or Orange (480/277V)
 - c. C phase: Blue (208/120V) or Yellow (480/277V)

- d. G Ground: Green
- G. Temporary connectors shall include protective flip lids to prevent accidental contact.
- H. Permanent connectors shall be broad range set-screw type, located behind an aluminum barrier.
- I. Short Circuit & Withstand Rating
 - 1. 65kAIC minimum, unless otherwise indicated on drawings.
- J. Voltage:
 - 1. 480/277V
- K. Current Rating:
 - 1. As indicated on Drawings
- L. Phase Rotation Monitor Device:
 - 1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal.
- M. Circuit Breakers:
 - 1. UL 489 Listed
 - 2. Circuit breakers shall be removable for service and maintenance
 - 3. Circuit breakers rated 1200A or greater shall contain a maintenance mode switch which complies with NFPA 70 Article 240 arc energy reduction requirements. The maintenance mode switch shall temporarily modify the trip settings of the circuit breaker to reduce the available arc energy downstream of the circuit breaker.
 - 4. Circuit breakers for load bank connectors shall have a shunt trip coil, and shall be wired to trip the circuit breaker when a start signal is received from the transfer switch.
- N. Additional accessories shall be included in submittal drawings as follows:
 - 1. Two-wire auto-start
 - 2. Battery charger receptacle, NEMA 5-20R
 - 3. Battery charger receptacle, NEMA 5-20R, GFCI
 - 4. Block heater receptacle
 - 5. Extra-depth for bottom conduit entry.
 - 6. Kirk key door interlock
 - 7. Strip heater and thermostat
 - 8. Surge protection device
 - 9. Load dump receptacle
 - 10. Utility light.
 - 11. Alarm contacts to indicate that the permanent emergency source is disconnected from the emergency system. Contacts shall change state when the generator feed circuit breaker is in the open position.

2.3 ALARM PANEL

- A. Description: Annunciator/alarm panel to indicate that the permanent emergency source is disconnected from the emergency system
- B. Features:
 - 1. Enclosure: Steel, flush or surface mountable
 - 2. Indicating Light: Red LED
 - 3. Buzzer
 - 4. Silence Button
 - 5. Operating Voltage: 24VDC

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Surface, Flush or Base Mounted: Determined by Application
 - 1. Concrete bases: 4 inches high above finished grade, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of the enclosure. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems." Install anchor bolts to elevations required for proper attachment to Generator Docking Station.
- B. Power Wiring: Make connections to power distribution system as indicated on Drawings. Install wiring as required by Section 260519: "Low Voltage Power Conductors and Cables."
- C. Control Wiring: Install wiring as required by Section 260519: "Low Voltage Power Conductors and Cables."
 - 1. Start Circuit: Provide 2-wire start circuit wiring to the emergency system transfer switch(es) for installations where the generator docking station is connected to the emergency power system. Terminate 2-wire start circuit wiring at a terminal block inside generator docking station and label "Generator Start Circuit."
 - 2. Alarm Panel: Provide wiring from the docking station to the alarm panel. Where the alarm panel requires an external power source, provide a dedicated 120V circuit from a spare circuit breaker in the nearest panelboard.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections to include the following:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes test and inspection results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262550

SECTION 264200 – CATHODIC PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies complete galvanic sacrificial anode type cathodic protection systems for underground steel tanks and piping. The section also includes devices to electrically isolate the system being protected.
- B. The services required include planning, installation, adjusting and testing of a cathodic protection system, using sacrificial anodes for cathodic protection of the Water, Fire Protection and Natural Gas line piping and above-ground appurtenances. The cathodic protection system shall include anodes, cables, connectors, corrosion protection test stations, and any other equipment required for a complete operating system providing the NACE criteria of protection as specified. Insulators are required whenever needed to insulate the pipes from any other structure. Any pipe crossing the water, fire protection, natural gas pipe shall have a test station.

1.2 RELATED WORK

- A. Section 33 10 00, WATER SYSTEMS

1.3 QUALITY ASSURANCE

- A. The Contractor shall be regularly engaged in the installation and testing of cathodic protection systems. Contractor's personnel shall be experienced, and shall be supervised by an engineer who is accredited as a Corrosion Specialist or Cathodic Protection Specialist by the National Association of Corrosion Engineers (NACE) International.
- B. Cathodic protection for underground metal piping tanks shall be designed in accordance with NACE SP0169-2013.

1.4 SUBMITTALS

- A. In accordance with the following requirements:
 - 1. Design Submittal: For cathodic protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the corrosion engineer responsible for their preparation.
 - a. Conduct site tests necessary for design, including soil resistivity, close-interval potential surveys, testing during construction, interference testing, and training of District's personnel.
 - b. Provide system design calculations, stating the maximum recommended anode current output density, and the rate of gaseous production, if any, at that current density.
 - 2. Furnish catalog cuts and shop drawings for the following items:
 - a. Anodes.
 - b. Cable and wire.
 - c. Test stations.
 - d. Terminal boxes.
 - e. Isolating flanges, unions, coatings, casing seals.
 - f. Exothermic welding devices.
 - g. Cable splice kits.
 - h. Layout drawings, wiring diagrams.
 - i. Test instruments.
 - j. Dielectric tape.
 - k. Test connection points.

3. Detail drawings consisting of a complete list of equipment and material and complete wiring and schematic diagrams, as well as any other details required to demonstrate that the system will function properly.
4. Designer's accreditation as a Corrosion Specialist or Cathodic Protection Specialist by NACE International.
5. Test reports in booklet form tabulating all field tests and measurements performed, upon completion and testing of the installed system and including close interval potential survey, casing and interference tests, final system test verifying protection, insulated joint and bond tests, and holiday coating test. A certified test report showing that the connecting method has passed a 120-day laboratory test without failure at the place of connection, wherein the anode is subjected to maximum recommended current output while immersed in a three percent sodium chloride solution.
6. Operation and Maintenance Manual:
 - a. Basic system operation.
 - b. Instructions for dielectric connections, interference and sacrificial-anode bonds; and precautions to ensure safe conditions during repair of pipe, tank or other metallic systems.
 - c. Locations of all anodes, test stations, and insulating joints.
 - d. Structure-to-reference cell potentials.
 - e. Recommendations for maintenance testing, including instructions for pipe-to-reference cell potential measurements and frequency of testing.
 - f. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
7. Certifications: Two weeks prior to final inspection, submit the following:
 - a. Certification by the manufacturer that the cathodic protection system conforms to the requirements of the drawings and specifications.
 - b. Certification by the Contractor that the Cathodic protection system has been properly installed and adjusted.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - B8-11..... Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - B843-13..... Magnesium Alloy Anodes for Cathodic Protection
 - D1248-12..... Polyethylene Plastic Extrusion Materials for Wire and Cable
 - F1182-13..... Anodes, Sacrificial Zinc Alloy
 - G57-06..... Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method
- C. American Society of Mechanical Engineers (ASME):
 - B16.1- Pipe Flanges and Flanged Fittings
 - 15.....
- D. National Association of Corrosion Engineers (NACE) International:
 - Control of External Corrosion on Underground or Submerged
 - SP0169-2013..... Metallic Piping Systems

PART 2 - PRODUCTS

2.1 ANODES

A. Type: Type II, factory-packed in cloth bag or box containing prepared backfill mixture, with lead wires.

B. Construction:

1. Alloy Specifications:

Element	Percent of Weight
Aluminum	0.010 Max.
Manganese	0.50 - 1.30
Zinc	0.05 Max.
Silicon	0.50 Max.
Copper	0.02 Max.
Nickel	0.001 Max.
Iron	0.03 Max.
Other	0.30 Max.
Magnesium	Remainder

2. Core: Galvanized steel.

3. Lead Wire: Factory installed, No. 12 solid copper, 3 M (10 feet) long, with TW or THWN insulation.

4. Lead Wire Attachment to Core: Silver solder the lead wire to the anode core, and seal the connection with an epoxy sealing compound. Dielectric material shall extend past the connection and cover the lead wire insulation by not less than 12 mm (1/2 inch).

5. Packaging: Permeable cloth bag or box with backfill mixture completely surrounding anode 12 mm (1/2 inch) minimum.

a. Components:

Hydrated Gypsum	75 percent
Powdered Bentonite	20 percent
Anhydrous Sodium Sulphate	5 percent

b. Center the anode in the firmly packed backfill using spacers.

2.2 INSULATED CABLE

A. Single conductor, stranded, annealed copper, Type HMWPE (high molecular weight polyethylene) insulation.

B. Construction:

1. Thickness of insulation:

AWG-SIZE	mm (inches)
No. 8	2.8 (7/64)
No. 6	2.8 (7/64)
No. 4	2.8 (7/64)
No. 2	2.8 (7/64)
No. 1	3.2 (8/64)
No. 1/0	3.2 (8/64)

2. Insulation: ASTM D1248, Type 1, Class C, Category 5, Grade E5.

3. Conductors: ASTM B8.

C. Lead wires terminating at a junction box or test station shall have a cable identification tag.

2.3 CABLE CONNECTIONS

A. Connections between cables and tank, pipes, casings, or structures shall be exothermic welding process. Connections between cables and between cables and leads shall be corrosion-resistant split bolts.

B. Insulation of Cable-to-Cable Connections: Epoxy-resin splice kits with two-part resin, mold, sealing mastic.

C. Coating of Cable Connections to Protected Structures: Field-applied coating similar to that on the protected structure.

2.4 CABLE AND WIRE IDENTIFICATION TAGS

A. Stainless steel material with engraved letters. Print letters and numbers a minimum of 5 mm (3/16 inch) in size. Provide identifier legend in accordance with the drawings.

2.5 TEST STATIONS

A. Type: Weatherproof, located at grade, or aboveground if so shown on the drawings. Enclosed terminals for anode leads, test leads, leads attached to protected system, and connection points for test instruments

B. Construction:

1. Housing: The unit shall be of standard design, manufactured for use as a cathodic protection test station, complete with locking cover, terminal board, shunts, and brass or stainless steel hardware.

2. Provide terminal boards for anode junction boxes, bonding boxes, and test stations made of phenolic plastic. Insulated terminal boards shall have the required number of terminals (one terminal required for each conductor). Install solderless copper lugs and copper bus bars, shunts, and variable resistors on the terminal board as indicated. Test station terminal connections shall be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes). Conductors shall be permanently identified by means of tags to indicate termination. Each conductor shall be color coded as follows:

Anode lead wire - black

Structure lead wire – white

Reference electrode lead wire - red

2.6 PERMANENT REFERENCE ELECTRODES

A. Permanent reference electrodes shall be zinc specifically manufactured for underground use, 10 inch diameter, by 24 inches long, plastic tube with an ion trap to minimize contamination of the cell. The cell shall be prepackaged by the manufacturer with a backfill material as recommended by the manufacturer. Provide cells with No. 14 HMWPE cable of sufficient length to extend to the test station without splicing. Reference electrodes shall have a minimum 15 year life, and stability of plus or minus 5 millivolts under 3 microampere load.

2.7 DIELECTRIC TAPE

A. Vinyl plastic electrical tape, 0.18 to 0.25 mm (7 - 10 mils) thick, pressure-sensitive adhesive.

2.8 WARNING TAPE

- A. 50 mm (2 inches) wide, detectable with metal detector, mylar-encased aluminum, orange color, imprinted "Cathodic Protection Cable Below" or similar.

2.9 DIELECTRIC INSULATION

- A. Rubber-based, 13 mm (0.5 inch) thick.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Anodes:
1. Excavate hole to a minimum 3 inches larger than the packaged anode diameter, and a minimum of two feet deep. Install in native soil, 3 feet minimum from protected structure, below centerline of protected structure, and at locations shown. Backfill shall be native soil. Install anodes adjacent to fuel tanks vertically.
 2. Do not lift or support anode by the lead wire. Where applicable, remove manufacturer's plastic wrap/bag from the anode. Exercise care to preclude damaging the cloth bag and the lead wire insulation.
 3. Center the packaged anode in the hole with native soil in layers not exceeding 150 mm (6 inches). Hand tamp each layer to remove voids taking care not to strike the anode lead wire. When the backfill is 6 inches above the top of the anode, pour not less than ten gallons of water into the hole to saturate the anode backfill and surrounding soil. Anodes shall not be backfilled prior to inspection and approval by the IOR or Corrosion Specialist.
- B. Cables and Anode Leads:
1. Burial: 2 feet minimum below finished grade, 6 inches minimum separation from other underground structures, backfill material in contact with cable free of rocks and debris. Cover the lead wire trench bottom with a 3 inch layer of sand or stone free earth. Center wire on the backfill layer, do not stretch or kink the conductor. Place backfill over wire in layers not exceeding 6 inches deep, and compact each layer thoroughly. Do not place tree roots, wood scrap, vegetable matter and refuse in backfill. Place cable warning tape within 18 inches of finished grade, above cable and conduit.
 2. Continuity Bonds: Use cable to connect adjacent protected structures, and protected structures separated by non-welded connectors. Provide 25 percent additional length as slack to allow differential movement of protected systems.
 3. Connections: Provide clean, bright, bare metal surface at all connection points. Connect anode lead wire(s) to the test station terminal board(s) by use of exothermic welds. Clean the structure surface by scraping, filing or wire brushing to produce a clean, bright surface. Weld connections using exothermic kit(s) in accordance with the kit manufacturer's instructions. Check and verify adherence of the bond to the substrate for mechanical integrity by striking the weld with a 2 pound hammer. Cover connections with an electrically insulating coating which is compatible with the existing coating on the structure. Allow sufficient slack in the lead wire to compensate for movement during backfilling operation.
 4. Warning Tape: Install 6 inches below grade, directly above cables.
- C. Test Stations: Provide test stations and permanent reference electrodes as follows:
1. At all above-ground water, fire water and natural gas appurtenances.
 2. At all insulating joints.
 3. At both ends of casings.
 4. Where the pipe crosses any other pipes.
 5. Where the pipe connects to an existing piping system.
 6. Where the pipe connects to a dissimilar metal pipe.
 7. Anchor terminal board firmly 2 feet minimum above grade for above grade units. Connect all anodes and protected structure to the test stations.
- D. Anchor terminal board firmly 2 feet minimum above grade for above grade units. Connect all anodes and protected structure to the test stations.

- E. Dielectric Insulation:
 - 1. General: Provide complete dielectric insulation between protected and unprotected systems and between protected systems and structures which could ground the cathodic protection. Required insulation points include all pipe entrances to buildings, manholes, and pits.
 - 2. Flanges: Install in locations open to view after completion of construction. Provide insulating gaskets, insulating sleeves on all bolts, insulating washers under bolt heads and nuts.
 - 3. Unions: Install in locations open to view after completion of construction. Unions not permitted in pipe sizes over 2 inches.
 - 4. Wall Penetration Seals: Install in space between pipes and wall sleeves at building and manhole walls.
 - 5. Coatings: Completely coat all pipe or conduit areas that are in contact with concrete.

- F. Permanent Reference Electrode Calibration and Installation:
 - 1. Provide zinc reference electrode(s) as indicated on the drawings.
 - 2. Prior to installation, soak the prepackaged reference electrode in a container of potable water for 30 minutes.
 - 3. Calibrate the permanent reference electrode in the presence of the IOR or Corrosion Specialist measuring the potential difference between the permanent reference electrode and an independent (portable) calibrated reference electrode placed in the water adjacent to the permanent reference electrode. Potential differences between the two electrodes of the same generic type should not exceed 15 millivolts when the sensing windows of the two electrodes being compared are not more than 2 mm (1/16 inch) apart but not touching. Zinc permanent reference electrodes should be within the range of 1000 to 1150 millivolts when calibrated with an independent (portable) calibrated copper-copper sulfate reference electrode with the two electrodes being not more than 2 mm (1/16 inch) apart but not touching. Permanent reference electrodes not within these potential differences shall be removed and replaced at the Contractor's expense. Prior to completely backfilling over reference electrodes, again verify the accuracy of the reference electrode. The testing provision shall also apply to replacement reference electrodes as well

3.2 RECONDITIONING OF SURFACES

- A. Restoration of disturbed surfaces in kind, or as shown in the contract documents.

3.3 FIELD QUALITY CONTROL

- A. Provide system with a calculated design life exceeding 40 years.

- B. Pre-construction Survey: The Corrosion Specialist shall perform a soil resistivity survey using the Wenner Four-Pin Method as described in ASTM G57. Survey entire length of proposed protected system at the structure depth. Also survey native-state structure-to-soil potential, soil pH, and presence of stray currents.

- C. Calculations: The Corrosion Specialist shall perform engineering calculations to verify the design of the system shown. Inform the Government of any recommended changes in the system design shown.

- D. Field Inspections During Construction: The corrosion specialist shall inspect the work at least twice to ascertain that there is no grounding, short circuits, coating damage, and that installation is in accordance with requirements.

- E. Final Inspection:
 - 1. Performed by Corrosion Specialist; witnessed by IOR or District.
 - 2. Test Instruments:
 - a. Digital Volt-Ammeter with impedance of 7-10 mega-ohms/volt.
 - b. Saturated copper-copper sulfate reference electrode.
 - c. Other instruments as required.
 - 3. Procedures: Conform to NACE RP0169.
 - 4. Test Results Required for Acceptance:

- a. Potential of minus 0.85 volt between protected structure and reference electrode.
 - b. Minimum shift of minus 300 millivolts upon application of protective current. Voltage measured between protected structure and reference electrode.
 - c. Minimum shift of minus 100 millivolts upon interruption of protective current. Voltage measured between protected structure and reference electrode.
 - d. Amperage value sufficient that anode life 40 years can be calculated. Provide calculations.
5. Test Report: Submit a complete report to IOR OR District showing all test measurements, calculations, list of instruments used. All structure-to-electrolyte measurements, including initial potentials and anode outputs, shall be recorded on applicable forms. Identification of test locations, test station and anode test stations shall coordinate with the as-built drawings and be provided on system drawings included in the report. The contractor shall locate, correct, and report to the IOR OR DISTRICT any short circuits encountered during the checkout of the installed cathodic protection system.
 6. One Year Warranty Period Testing: The Contractor shall inspect, test, and adjust the cathodic protection system semi-annually for one year, 2 interim inspections total, to ensure its continued conformance with the criteria outlined below. The performance period for these tests shall commence upon the completion of all cathodic protection work, including changes required to correct deficiencies identified during initial testing, and preliminary acceptance of the cathodic protection system by the IOR OR Corrosion Specialist. Copies of the One Year Warranty Period Cathodic Protection System Field Test Report, including field data, and certified by the Contractor's corrosion engineer shall be submitted to the IOR OR District.

3.4 AS-BUILT DRAWINGS

- A. Provide the District with one set of as-built drawings in hard copy and CD Rom showing dimensioned locations of all anodes, cables, test stations, and anode weights. Provide identification of test stations and anodes keyed to test reports.

3.5 INSTRUCTION

- A. Furnish the services of a factory-trained technician for one 4-hour period to instruct personnel in the operation, maintenance, safety, and emergency procedures of the cathodic protection system on the date requested by the District. The instructions shall cover all items contained in the operation and maintenance manual.

END OF SECTION

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LED: Light-emitting diode.
- D. LER: Luminaire efficacy rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. L70: Point in time where light fixture lumen output is 70% of initial light output.
- H. McAdams Ellipses: Color consistency of LED's from chip to chip.

1.2 SUBMITTALS

- A. Refer to Sections 012500 "Substitution Procedures" and 013300 "Submittal Procedures."
- B. Product Data: For each type of lighting fixture, arranged in order of fixture designation as listed on the fixture schedule. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Energy-efficiency data.
 - 4. Lamp data: rated life, lumen output, CCT, CRI and wattage.
 - 5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
- C. Photometric Data Submittals
 - 1. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, for the following lighting fixture types. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
 - b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 2. Include the following in the photometric report:
 - a. List the measured candela values of the photometric distribution in at least three planes, except in the case of an axially symmetrical lighting fixture. Candela curves, lux (footcandle) and lumen tables, and iso-lux (iso-footcandle) contours are not acceptable.
 - b. List the type of lamps, ballasts, and lighting control devices, such as lenses and louvers, used with the tested lighting fixture.
- D. Shop Drawings: For nonstandard or custom lighting fixtures as indicated on the fixture schedule. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring Diagrams: For power, signal, and control wiring.
- E. Installation instructions.
- F. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Lighting fixtures.
 2. Ceiling-mounted projectors.
 3. Structural members to which suspension systems for lighting fixtures will be attached.
 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.
 - f. Access panels.
- G. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
- H. Product Certificates: Compatibility for each type of ballast for bi-level and dimmer-controlled lamps and fixtures as specified, from manufacturer.
- I. Field quality-control reports.
- J. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.
- K. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.
- E. Provide fixtures U.L. listed and labeled for the application.
- F. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.4 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.5 ALLOWANCES

- A. Extra Fixtures
 - 1. Provide an additional **5** exit signs, Type "**X**" above what is indicated on the drawings. Include for each of the extra units, installation of 75 feet of conduit and wire, and connection to the emergency system.
 - 2. Install devices at locations to be determined by the Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product by manufacturers indicated on Drawings and specified.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. LED Fixtures: Minimum rated lifetime of L70 at 50,000 hours based on IES LM-79 testing; passive thermal management only unless otherwise indicated.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - b. Distribution: **Pattern 12**
 - c. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
- G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.

- b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
- c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
- d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
- e. ANSI ballast type (M98, M57, etc.) for HID luminaires.

- H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 LED MODULES/BOARDS

- A. Minimum rated lifetime of L70 at 50,000 hours based on IES LM-80 testing; 4-step McAdams Ellipse maximum color consistency unless otherwise indicated; 80 CRI minimum unless otherwise indicated.

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - 1. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General
 1. Install lighting systems in accordance with NECA/IESNA 500, 501 and 502.
 2. Assemble and install lighting fixtures in a manner to insure a straight and true installation without dents, warps, and other irregularities.
 3. Where lighting fixtures are specified or indicated for installation in continuous rows, install fixtures in a continuous end-to-end manner without gaps between fixture segments, and with vertical and horizontal variations, along the length of the continuous installation, no greater than 6 mm (1/4 inch).
 4. Coordinate the lighting system installation with relevant trades so as to eliminate installation interferences, such as with hangers, mechanical ducts, sprinklers, piping and steel structure.
 5. Provide plaster frames for recessed fixtures installed in other than suspended grid ceiling systems.
- B. Lighting fixtures:
 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 2. Install lamps in each luminaire.
- C. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
 1. Install ceiling support system rods or wires for each fixture, independent of the ceiling suspension devices. Locate not more than 6 inches from lighting fixture corners.
 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
5. Install suspended lighting fixtures at mounting heights specified or indicated, plus or minus 6 mm (1/4-inch).

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 CLEANING

- A. Clean interior surfaces of lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints, smudges, and other marks from lenses, louvers, and reflecting surfaces. Leave free of visible marks.

3.5 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust the lamp socket position in downlight lighting fixtures per the manufacturer's recommendations for the specified lamp type and voltage. Optimize the lighting output of the lighting fixture by properly locating the light center within the reflector.
2. Upon final completion of the installation of the lighting fixtures and any associated lighting control systems, notify the Architect in writing to arrange for the final adjustment and aiming of lighting equipment requiring aiming and adjustment.
3. Adjust aimable luminaires in the presence of Architect and Lighting Designer.

END OF SECTION

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
1. Lamps, including life, output (lumens, CCT, and CRI) and energy-efficiency data.
 2. Photometric data and adjustment factors based on laboratory tests, complying with [IES LM-79][IES LM-80]
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficiency Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 3. Wiring diagrams for power, control, and signal wiring.
 4. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings:
1. For nonstandard or custom luminaires.
 - a. Include plans, elevations, sections, and mounting and attachment details.
 - b. Include details of luminaire assemblies. Include dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Include diagrams for power, signal, and control wiring.
 2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.2 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective cover prior to shipping.

1.5 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of the luminaire installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Internal driver.
- I. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- J. L70 lamp life of 50,000 hours.
- K. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- L. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- M. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
- N. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- O. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming.[Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.]

3.2 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.3 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole unless otherwise indicated.
 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole.
 2. Install grounding conductor and conductor protector.
 3. Ground metallic components of pole accessories and foundations.

3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
1. Adjust the lamp socket position in downlight lighting fixtures per the manufacturer's recommendations for the specified lamp type and voltage. Optimize the lighting output of the lighting fixture by properly locating the light center within the reflector.

2. Upon final completion of the installation of the lighting fixtures and any associated lighting control systems, notify the Architect in writing to arrange for the final adjustment and aiming of lighting equipment requiring aiming and adjustment.
3. Adjust aimable luminaires in the presence of Architect and Lighting Designer.

END OF SECTION 265600

SECTION 27 0000 - COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes general information that applies to all Division 27 specifications.
- B. Related Sections:
 - 1. 270820: Copper Testing
 - 2. 271500: Communications Horizontal Cabling
 - 3. 271600: Communications Connecting Cords Devices & Adapters

1.2 REFERENCES – TO BE CONSIDERED AS A PART OF THIS SPECIFICATION

- A. Most recent editions and addenda of the following documents:
- B. Chabot-Las Positas Community College District Cabling Infrastructure Standards (CLPCCD District Information Technology Services Department)
- C. TIA-526 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant**
- D. TIA-568 Generic Telecommunications Cabling for Customer Premises
- E. TIA-568 Commercial Building Telecommunications Cabling Standard
- F. TIA-568 Balanced Twisted Pair Cabling Components
- G. ANSI/TIA/EIA 569 Commercial Building Standards For Telecommunications Pathways And Spaces
- H. ANSI/TIA/EIA 606 The Administration Standard For The Telecommunications Infrastructure Of Commercial Building
- I. ANSI/TIA—607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- J.
- K. TSB-4979 - Practical Considerations for Implementation of Encircled Flux Launch Conditions in the Field. This bulletin outlines precise specifications that define the launch condition of test sources into multimode fiber which have been standardized and are mandatory for testing optical attenuation of installed multimode cabling per TIA-568.
- L. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
- M. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual (TDMM).**
- N. Building Industry Consulting Service International (BICSI) Customer Owned Outside Design Manual.
- O. ISO/IEC 11801 – Information Technology – Generic Cabling for Customer Premise

- P. IEEE 802.3 Standard for Information technology -Telecommunications and information exchange between systems - Local and metropolitan area networks – Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
 - Q. IEC 61156, Multicore and Symmetrical Pair/Quad Cables for Digital Communications – Part 1: Generic Specification, 2005
 - R. NFPA-70 National Electrical Code 2008 edition
 - S. NECA/BICSI-568-A Standard for Installing Commercial Building Telecommunications Cabling
 - T. NESC – National Electrical Safety Code
 - U. **NFPA-70**
 - V. UL 444 – Standard for Safety of Communications Cable
 - W. UL 1666 – Standard for Safety of Flame Propagation Height
 - X. NFPA 262 – Flame Travel and Smoke of Wires and Cables
 - Y. IBC 714.3.2
 - Z. ASTM E 814 / UL 1479
 - AA. Local Authority Having Jurisdiction
 - BB. CLPCCD Cabling Infrastructure Standards
- 1.3 DEFINITIONS / TERMS / ACRONYMS
- A. ANSI American Northern Standards Institute
 - B. AWG American Wire Gauge
 - C. BICSI Building Industry Consulting Service International
 - D. BCT Bonding Conductor for Telecommunications
 - E. COTS Common Off The Shelf Technologies
 - F. EIA Electronics Industry Alliance
 - G. ETL Intertek Semko Labs
 - H. FCC Federal Communications Commission
 - I. GE: Grounding Equalizer
 - J. IEC International Electrotechnical Commission
 - K. IEEE Institute of Electrical and Electronic Engineers
 - L. IDC Insulation displacement contact

- M. ISO International Standards Organization
- N. J-STD Joint Standard
- O. NECA National Electrical Contractors Association
- P. NFPA National Fire Protection Agency
- Q. SC TIA Standard duplex connector
- R. TIA Telecommunications Industry Association
- S. UL Underwriters Laboratory
- T. As Necessary: That work which is required for completed construction, but is not necessarily shown or described in the Contract Documents.
- U. As Required: That work which is required for completed construction and is shown on the drawings or described in the project Specification.
- V. Cabling: Cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.
- W. Backbone: A facility (e.g., pathway, cable or conductors) between telecommunications rooms, or floor distribution terminals, the entrance facilities and equipment rooms within or between buildings.
- X. Backbone Cabling: Cabling and connecting hardware that provides interconnections between telecommunications rooms, equipment rooms, and entrance facilities.
- Y. BICSI: Building Industry Consulting Service International.
- Z. Concealed: Hidden from sight, buried as in chases, furred spaces, shafts, fixed ceiling or embedded in construction.
- AA. Contractor: The installation Contractor responsible for the furnishing and installation of all work indicated within this Specification.
- BB. Construction Manager: The Owner's appointed representative.
- CC. Equipment Outlet (EO): A device also known as the outlet or information outlet placed at the user workstation for termination using connectors (jacks) of horizontal media for connectivity of data and voice at teacher work area outlet, multimedia equipment. These outlets provide the connection point to voice, data, and other media services.
- DD. Exposed: Bare, open to the elements, out in the open, uncovered.
- EE. Furnish: Purchase, supply, provide and deliver to the project site, protect and provide interim storage and be ready for unloading, unpacking, assembly, installation, and similar operations in accordance with Manufacturer's specifications."
- FF. GE Grounding equalizer: Employed in a multistory building to interconnect multiple TBBs on the same floor. Sized equal to TBB.

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- GG. Horizontal Cabling: Cabling between and including the work area outlet/connector and the horizontal cross-connect/patch cord in the telecommunications room.
- HH. Install: Describes operations at project site including the actual "unloading, unpacking, rigging in place, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations".
- II. Installer: Contractor, Subcontractor and/or supplier who uses their own employees for performance of all construction activity related to their specified responsibilities, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform and the "Installers" must be an authorized Manufacturers representative, certified, experienced and qualified to provide, install, program, troubleshoot, train, warrant and service all the systems in this section in their entirety.
- JJ. If Applicable: That work which may be required for completed construction at applicable locations, but is not necessarily shown or described in the Contract Documents.
- KK. Owner: Person or entity for which the building and construction is being done; and/or that will take possession of the property once the construction is complete.
- LL. Owner Representative: The person or entity representing the Owner on contractual matters.
- MM. Product: Any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
- NN. Provide: To "furnish and install, complete and ready for the intended use".
- OO. RCDD: Registered Communications Distribution Designer (RCDD).
- PP. Substantial Completion: The project is sufficiently complete to be utilized for its intended use as stated in the body of this written Specification.
- QQ. TBB: Telecommunications Bonding Backbone
- RR. TGB: Telecommunications Grounding Busbar
- SS. TMGB: Telecommunications Main Grounding Busbar
- TT. Words in the singular: Will also mean and include the plural, wherever the context so indicates, and words in the plural will mean the singular, wherever the context so indicates.

1.4 SUBMITTAL REQUIREMENTS

- A. General
 - 1. Provide required submittals in accordance with Conditions of the Contract, and Division 1 Submittal Procedures Section.
 - 2. Format:
 - a. For this section furnish submittal data neatly bound in an 8 1/2" x 11" folder or binder for each specification section with a table of contents listing materials by Section and paragraph number.
 - b. Project name and address
 - c. Number of submittal
 - d. Name and address of the contractor
 - e. Date of submittal
 - f. Table of contents with material page numbers listed

- g. Page number of the corresponding specification or drawing numbers in the contract documents.
3. Submittals to consist of:
 - a. Detailed shop drawings,
 - b. Product specifications,
 - c. Block wiring diagrams,
 - d. "Catalog cuts" and data sheets containing physical and dimensional information,
 - e. Performance data,
 - f. Electrical characteristics
 - g. Materials used in fabrication, and material finish.
4. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories which are included and those which are excluded.

B. Material submittals

1. Label each submittal with the Specification Section Number and provide a cover letter or stamp stating that the submittal has been thoroughly reviewed by the Contractor and complies with the requirements of the Contract Documents. Failure to comply with this requirement will constitute grounds for rejection of data.
2. For each product, indicate where it is intended to be installed.
3. Resubmittals: Provide a cover letter with the resubmittal that lists the action taken and revisions made to each product submittal in response to Submittal Review Comments, *indicating the page in the resubmittal that the new information occurs*. Failure to include this cover letter will constitute rejection of the resubmittal package and no review will occur.

C. Under the provisions of this request for proposal, prior to the start of work the Structured Cabling System Contractor will:

1. Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this spec.
2. Submit proof from Manufacturer of Contractor's good standing in Manufacturer's program where contractor is authorized by manufacturer to do warranted work.
3. Submit appropriate cut sheets and samples for all products, hardware and cabling.
4. Work will not proceed without the Owner's approval of the submitted items.
5. The Structured Cabling Systems Contractor will submit in writing any material substitutions they propose and receive approval from the Owners on all substitutions of material in writing prior to purchase and installation. No substituted materials will be installed except by written approval from the Owner.
6. Refer to other applicable sections for additional submittals requirements.

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D. Provide Indexed Project Manual composed of Test Results, As-Built drawings, material cut sheets, maintenance instructions, Parts List (with part numbers) of all materials installed, etc., at the completion of project.

E. Final close out documents including but not limited to bound indexed test results, project manual that includes such items as manufacturer and contractor warranties, product cut sheets, material submittals, etc.

1. Provide Building Structured Cabling Systems Administration Report indicating TIA/EIA-606 required information.
2. Hard copy documentation of test results for every cable segment and link in 3- ring binder. Documents will include measured values as well as whether or not the test passed.
3. Provide "As-Built" Drawings on AutoCAD Version the same as provided by architect to the Owner. Obtain copy of original Drawings from the Architect.
 - a. "As-Built" drawings indicating location of all equipment including but not limited to work area outlets, patch panels, cross connect blocks, on each segment and cable routing outlet and identifiers. Indicate labeling for each piece of equipment.

- b. Provide respective copies mounted in each telecommunications room, and the main cross connect.
 - c. As-Built drawings will contain all installed cabling and materials. Outlets will be numbered with each cable associated with the work area outlet.
4. Place a laminated ½ or full-size floor plan of these drawing (coordinate with Owner) on the wall of each communications room.

1.5 QUALITY ASSURANCE

- A. The Telecommunications Subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the telecommunications drawings and specifications. The Telecommunications Subcontractor shall be a company specializing in the design, fabrication and installation of integrated telecommunications systems.
- B. Telecommunications Systems specified shall be engineered, assembled and installed under the direction of a pre-qualified Telecommunications Subcontractor. Pre-qualification requirements shall include submittal by the Telecommunications Subcontractor to the Architect of the following:
 1. List of previous projects of this scope and nature, including names and sizes of projects (to include square footage and construction cost – overall and that of the Telecommunications Subcontractor), description of work, times of completion, and names of contact persons for reference.
 2. Installers shall certify that they are manufacturer-authorized or trained for work to be performed.
- C. The Installer (Firm and Employees) will be experienced in the operations they are engaged to perform. Demonstrate at least five years of continuous recent experience on similar projects. The Installer will hold recent, up-to-date licenses, certifications and training certificates in the area the project is located and for the equipment to be installed.
- D. The Telecom contractor shall be a CommScope Authorized Partner whose work, upon completion, will result in the provision of CommScope Network Infrastructure System 25 Year Extended Product and Application Warranty for the TeraSPEED fiber and SYSTIMAX Category 6A UTP infrastructure. CommScope will provide a numbered, registered System Warranty Certificate.
- E. Provide names of contacts from the last five similar projects including the General Contractor, Owner's Representative, Architect and Engineer. Indicate project locations, scope and current phone numbers that the contacts can be reached at.
- F. Qualified Structured Cabling System Installation firms will have demonstrable design and installation training with certifications of competence. Certified training will be industry recognized and at least equal to:
 1. Building Industry Consulting Service International, Inc. (BISCI) Registered Installer.
 2. Registered Communications Distribution Designer (RCDD).
 3. Manufacturer Certified Installer
- G. Provide a full time on site foreman who personally has been certified as described above. Submit all documentation under this Section.
- H. Provide an on-call Project Manager to supervise the project.
- I. Each Foreman and Installer working on this project will be trained to the qualified level as specified by the Manufacturer(s) for installation and maintenance of equipment being provided on this project. The training will consist of at least a minimum of proper installation techniques of their specific equipment in order to have a complete operating system meeting or exceeding the requirements as specified herein. Each Foreman and Installer working on this project will have

documentation from the Manufacturer indicating that they have been adequately trained prior to the start of the project. Only Foreman and Installers who have been properly trained and documented by the Manufacturer whose equipment is being provided on this project will be allowed to install.

- J. Separate Qualifications Requirements:
- K. Installers will be specifically qualified for each system being installed under this section. Provide documentation for each installer including:
 - 1. State of CA License as required
 - 2. Registered Telecommunications Installer Apprentice Certificate
- L. Maintain at the site an updated copy of the Manufacturer Trained Installers list including a copy of their training documentation from the Manufacturer. This documentation will be made available to the Architect upon request.

1.6 BIDDER QUALIFICATIONS

- A. Bidding Contractor shall be licensed to install telecommunications systems in the state where work will be performed.
- B. Bidding Contractor shall have a minimum of 5 years of experience installing structured cabling for telecommunications.
- C. Bidding Contractor shall have the capability to bond project in its entirety.
- D. Bidding Contractor shall be able to provide insurance at the request of the owner.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Contractor shall ensure that materials delivery to work area shall be coordinated with construction site manager responsible for materials distribution to all trades.
- B. Contractor is responsible for all materials, tools and vehicles left on the job site.
- C. Contractor shall coordinate a disposal bin for the removal of all trash produced by the Contractor's associated personnel during the project.
- D. Contractor shall ensure materials are stored in an environmental area where:
 - 1. Temperature does not exceed 120 degrees Fahrenheit nor below 32 degrees Fahrenheit.
 - 2. Humidity does not exceed 80%.
 - 3. No direct exposure to sunlight.
- E. Cable shall be stored according to Manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable will be stored off site at the Contractor's expense.
- F. Deliver equipment in individual shipping splits for ease of handling, mount on shipping skids and wrap for protection.
- G. Inspect and report concealed damage to carrier within specified time.

- H. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation. Meet the requirements and recommendations of NFPA 70B and the Manufacturer. Location will be protected to prevent moisture from entering enclosures and material.
- I. Handle in accordance with NEMA and the Manufacturer's recommendations and instructions to avoid damaging equipment, installed devices and finish.
- J. The equipment will be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer will be required to brace the equipment suitably to ensure that the tilting does not impair the functional integrity of the equipment.

1.8 PROJECT CONDITIONS

- A. Environmental Requirements
 - 1. Contractor shall ensure that any pollutants produced during the work are disposed of according to local, state or national regulations. Follow the most stringent guidelines.
 - 2. It is preferred that the Communications Contractor recycle any used or un-used components during the course of the construction project.
 - 3. Coordinate with LEED project manager if cabling system or components will be used for points in a LEED certified project.
- B. Existing conditions
 - 1. Prior to bid, Telecommunications Subcontractor is to visit the existing building and evaluate all existing conditions. Bring to the attention of the Owner and Design Team any cause for concern or apparent conflicts with the contract documents as soon as practically possible.
- C. Field Measurements
 - 1. Contractor shall coordinate with electrical engineer on project that the main electrical service ground has a resistance to earth of less than 5 ohms.
 - 2. Contractor shall ensure that all grounding buss bars for all equipment network rooms shall have a resistance of less than 1 ohm back to the main electrical service ground.
 - 3. Contractor shall ensure that all field testers have been calibrated from the Manufacturer within 1 year.
 - 4. Refer also to grounding specification 27 05 26

1.9 PRE-CONSTRUCTION MEETING

- A. Attend a pre-construction meeting with ITS and Designated ITS design team (Ryan Raskop, Salter). Telecommunications pre-construction meeting will be coordinated by CLPCCD ITS

1.10 SEQUENCING

- A. Contractor shall coordinate with Owner's project manager on sequencing of various trades and construction teams for the lifecycle of the project.
- B. Cooperation and coordination with other trades.
 - 1. The work will be so performed that the progress of the entire building construction, including all other trades, will not be delayed and not interfered with. Materials and apparatus will be installed as fast as conditions of the building will permit and must be installed promptly when and as directed.
 - 2. Keep fully informed as to the shape, size and position of all openings required for all apparatus and give information in advance to build openings into the work. Furnish and set in place all sleeves, pockets, supports and incidentals.

3. Coordinate exact locations and roughing in dimensions of all work before installation and make all final connections as required. Any changes required to avoid interferences or to provide adequate clearances for Code and maintenance requirements will be made at no additional costs.
4. Structural elements of the project will not be relocated, altered or changed to accommodate the work without written authorization from the Owner/Architect.
5. Work that is installed before coordination with other trades or that causes interference with the work of other trades will be changed to correct condition at no additional cost to the Owner.
6. Obtain a complete set of Project Drawings and Specifications for coordination and to determine the full scope of work.
7. Attend project coordination meetings to coordinate work of this Section, pathways, work of other trades phasing and other project requirements.

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1.11 CONTINUITY OF SERVICE AND SCHEDULING OF WORK

- A. Refer to the overall scheduling of the work of the project. Schedule work, process Submittals and order materials and equipment to conform to this schedule and install work to not delay nor interfere with the progress of the project.
- B. Inform General Contractor and Architect immediately of any delays or potential delays. Furnish Manufacturer's letter to verify order date, equipment delays, expected shipment date, order number, and potential remedies to speed up delivery. Any costs to speed up delivery will be implemented at no cost to the project if the equipment or material was not ordered as soon as possible after Contract award or within the time frames indicated with the Submittals.
- C. Include premium time required to comply with the project scheduling and phasing.
- D. Be aware of, and plan for, project scheduling and phasing. Provide for complete continuous operation of all systems. Coordinate scheduling and phasing with the Architect, Owner, other Trades, and the General Contractor.

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1.12 LABELING

- A. CLPCCD ITS will provide the labeling scheme to be used for the telecommunications cabling.
- B. Document in digital format a set of plans with all elements and their unique numbers. Paper copies are not allowed by the District.
- C. Provide a definition or labeling matrix with As-Built/Document Close-Out submittals that defines each labeling element with examples of each field defined. All documentation shall be in digital format. Paper copies are not allowed by the District.
- D. Submit in digital format complete labeling scheme for all elements with initial submittals for project.
- E. Ensure labeling for backbone cables includes information on the space name/number of the cable's opposite end. This requirement includes buss bar, bonding conductor, and bonding backbone cable labeling.
- F. As a part of the close-out submittal package, provide riser cable and bonding conductors drawings showing the cables, their installed routes, and the cable numbers. These documents will be in addition to the As-Built floor plan submittals that identify work area outlet placement with their respective identification numbers. All submittals shall be in digital format. Paper copies are not allowed by the District.

1.13 POST CONSTRUCTION

- A. Meeting: Subsequent to substantial completion and testing, call a meeting with GC, Owner's representative, design consultant, and others deemed necessary by Owner &/or GC.
 - 1. At the meeting, contractor shall present a DRAFT of AS-Built drawings, test results, and any other material contractor deems appropriate to completing the project for review by other attendees.
 - 2. Any comments or requests for correction shall be noted by the contractor during the meeting. Corrections to all documents shall be made and final copies shall be submitted within 1 week of meeting.
- B. Punch Walk: Arrange with Owner's project team, GC, and consultant a final punch-walk to review completed installation.
 - 1. Document all discussion, comments, and requests by Owner's team, noting outstanding items that must be ameliorated.
 - 2. Complete all tasks on punch-list.
- C. Notification of completion of work: Notify Owner in writing when installation is complete. Arrange for a site walk thru with the Owner demonstrate that all punch list items have been completed.
 - 1. Record any Owner comments on items that may have been left incomplete whether or not they were a part of punch list.
 - 2. Complete any outstanding items.
- D. Failure to complete installation
 - 1. If the contractor calls for a punch walk because the contractor states that the installation is complete, and it is found to be incomplete and/or systems are not functioning thus requiring the contractor to do more work to complete the job, any re-visits for further punch walks will be charged to the contractor at our going hourly rate.
- E. Provide "As-Built" documentation to the design team for review and implementation of Record Drawing documents.

1.14 PROTECTION OF WORK AND PROPERTY

- A. Be responsible for the care and protection of all work included under this Section until it has been tested and accepted.
- B. Protect all equipment and materials from damage from all causes including theft. All materials and equipment damaged or stolen will be replaced with equal material or equipment at the option of the Architect and Owner.
- C. Materials and equipment stored for this project will be protected and maintained according to the Manufacturer's recommendations and requirements and according to the applicable requirements of NFPA 70B.
- D. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen and make good any damage caused.
- E. Use caution to avoid damage to existing work, and to prevent harm to personnel working in all areas.
- F. Observe all safety precautions and requirements for the construction.

- G. The General Contractor and the Installer are responsible for initiating, maintaining, and supervising all safety precautions and requirements during construction.
- H. Coordinate installations with all other trades in order to not damage equipment or cables during construction. Any work that is damaged during construction will not be repaired. Replace damaged work completely, with no splices in cabling, at no additional cost to the Owner.

PART 2 - PRODUCTS

- 2.1 REFER TO 27 05 26 FOR BONDING AND GROUNDING SPECIFICATIONS
- 2.2 REFER TO 27 11 00 FOR EQUIPMENT ROOM FITTINGS
- 2.3 REFER TO 27 15 00 FOR COMMUNICATIONS HORIZONTAL CABLING
- 2.4 REFER TO 27 16 00 FOR COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTERS
- 2.5 LABELING
 - A. Horizontal and grounding cabling: 1" white with black lettering. Dymo Rhino P/N 1734821
 - 1. Approved equal
 - B. Backbone cabling: 1" white nylon with black lettering: Dymo Rhino P/N 1734524
 - 1. Approved equal

2.6 CABLE SUPPORTS

- A. Provide 3/8" threaded rod for support of J-Hooks when conduit not utilized.
 - B. Minimum requirements:
 - 1. Sized to terminate Cat 6a data termination ports and power outlets as indicated on plans.
 - 2. UL listed for scrub water test and 2-hour fire rating while maintaining fire classification of floors.
 - 3. A maximum of 50 cables per J-Hook is allowed, regardless of the manufacturer's product specification
- Backbone cabling will be labeled at all pull points and ends with water proof labels using the following color schedule:
Voice copper backbone - white
Data fiber backbone - yellow
FA fiber backbone - red

PART 3 - EXECUTION

- 3.1 GENERAL
 - Labeling details will be provided by CLPCCD ITS at the Telecom Pre-Con
- A. CLPCCD ITS will perform site walkthroughs and inspections during the construction of the telecommunications infrastructure. Coordinate at regular meetings with ITS / Salter with work performed in the field.
- B. Include the cost of all work including sub-letting of any work that may be required to complete the work indicated in order to avoid work stoppages and jurisdictional disputes. The work to be sublet will conform to precedent agreements and decisions of record. Jurisdictional assignment will be a responsibility under this Section's contractual obligation.
- C. Do not install equipment and materials that have not been reviewed by the Architect. Equipment and materials which are installed without the Architect's review or without complying to comments issued with the review will be removed from the project when so instructed by the Architect. No

payment will be made for unapproved or removal if it is ordered removed. The Installer will be responsible for any ancillary costs incurred because of its removal and the installation of the correct equipment and materials.

- D. Obtain detailed information on installation requirements from the Manufacturers of all equipment to be furnished, installed or provided. At the start of construction, check all Contract Documents, including all Drawings and all Sections of the specifications for equipment requiring electrical connections and service and verify electrical characteristics of equipment prior to roughing.
- E. Equipment and systems will not be installed without first coordinating the location and installation of equipment and systems with the General Contractor and all other Trades.
- F. Any and all material installed, or work performed in violation of above requirements will be re-adjusted and corrected by the Installer without charge.
- G. Refer to all Drawings associated with the project, prior to the installation or roughing-in of the electrical outlets, conduit and equipment, to determine the exact location of all outlets.
- H. Label all equipment as herein specified.
- I. After installation, equipment will be protected to prevent damage during the construction period. Openings in conduits and boxes will be closed to prevent the entrance of foreign materials.
- J. Home runs indicated are not to be combined or reduced without written consent from the Architect.
- K. All connections to equipment will be made as required, if applicable, and in accordance with the approved submittal and setting drawings.
- L. Site Observation:
 - 1. Site observation visits will be performed randomly during the project by the Architect. Reports will be generated noting observations. Deficiencies noted on the site visit reports will be corrected. All work will comply with the Contract Documents, applicable Codes, regulations and local Authorities whether or not a particular deficiency has been noted in a site visit report.
 - 2. Be responsible to notify the Architect ten working days prior to closing in work behind walls, raised access floors, ceilings, etc., so that installed work can be observed prior to being concealed.
 - 3. Areas will stay accessible until deficiencies are corrected and accepted. Notify the Architect when all deficiencies are corrected. Return reports with items indicated as corrected prior to re-observation by the Architect.
 - 4.
- M. Change Orders, Modifications, Revisions and Directives:
 - 1. When change orders, modifications, revisions or Architect's Directives are issued or authorized, provide the required additional material, equipment, personnel and workers to prevent delays in the work, and to complete the work within the time limit of the Contract unless a specific time extension is requested with the change and accepted. Include costs for expediting deliveries where required.
 - 2. Requests for additional compensation will be submitted broken down and associated by item, tasks and Drawing or sketch number with material and labor costs, so quantities can be easily verified.
 - 3. Requests will be properly and adequately identified so the scope of work can be clearly determined. Indicate who originated change in work.
 - 4. Submit on all credits broken down as requested for adds. Credits will be separately identified and accounted for. Do not indicate as net changes with adds.

5. Unit costs for labor and material will be equal for adds, deletes and credits.
- N. Protect existing spaces where work is being performed; protect it from damage and from the accumulation of dirt and debris.
- O. Any ceilings, walls, floors, furniture, equipment, furnishings, etc., damaged by the work of this Section will be replaced, or at the Owner's option, repaired with similar materials, workmanship and quality.
- P. Work includes field survey of existing conditions, systems, equipment and tracing of existing circuits to determine scope of work.
- Q. Maintain the existing building in operation at all times during the entire construction period. If it is necessary to have a system shutdown, a written request for approval will be submitted in advance stating the estimated shutdown time. Work will be planned to minimize shutdown. Shutdowns will be at the convenience of the Owner and, if necessary, on premium time.
- R. Clean and touch up all equipment, materials and work sites at the completion of work in each area.
- S. Certain portions of the work area may be occupied during construction. Determine which areas and schedule work accordingly and include necessary premium time.
- T. Make sure necessary provisions to provide continuous service of all existing systems throughout all occupied areas.

3.2 CABLE PATHWAYS

- A. Install cables in pathways designed to support the cables per manufacturer instructions.
- B. Provide all equipment and cabling for a complete installed operating system. Cable tray pathways, outlet boxes and grounding are provided by the Electrical Subcontractor unless otherwise noted.
- C. All pathways provided under this Section will comply with fill capacities as per Code, TIA/EIA 569 and BICSI. Coordinate with electrical contractor prior to pathway installation to verify capacity.
- D. Cable bending radius will not be less than minimum required by TIA/EIA and BICSI.
- E. Cabling installed concealed will be supported from the building structure (e.g. cable trays, J-Hooks, etc.).
- F. Cables will be installed no closer than 12 inches (305mm) to electrical equipment and wiring. When cables are required to cross power wiring, they will only do so perpendicular to the power wiring. Cable and power wiring will only cross each other the minimal number of times as required due to building design limitations.
- G. Clearances: Clearances between cabling and other building systems as required by TIA/EIA 569 and BICSI will be maintained throughout the building.
- H. All cables will be installed in a neat and workman-like manner. Cables will be installed parallel and perpendicular to building elements.
- I. Provide expansion fittings and adequate cable slack at all building expansion joints.

- J. Fire/smoke seal around all conduits, raceways, sleeves, slots, etc. where cables pass from one location to another.

3.3 WORK AREA OUTLETS

- A. All work area outlet locations will be as indicated on the Drawings. Uniquely label each work area outlet and jack within the outlet according to the numbering convention outlined in the section on labeling.
- B. Labeling shall be sequential in order, do not reuse a number throughout the entire infrastructure.
- C. Work area outlets installed in casework will have their cables installed within the conduit or raceway provided.
- D. Install jack and connector modules as indicated in the details and on the Drawings.
- E. Work area outlets will be seated properly and will be installed level on walls and parallel to building elements as required.

3.4 INSTALLATION PRACTICES

- A. Follow and adhere to installation practices specified by the applicable Telecommunications Industry Association standards.
- B. Follow and adhere to installation practices specified by the most recent edition of BICSI Information Transport System Installation Manual.
- C. Follow and adhere to installation practices specified by the latest version of BICSI Telecommunications Distribution Methods Manual .
- D. Follow and adhere to installation practices specified by the latest version of NFPA-70 National Electric Code.
- E. Follow and adhere to installation practices specified by the Manufacturers.
- F. The general topology will be a "hierarchal star" configuration. All segments will originate in UL listed patch panels located in the telecommunication equipment racks/cabinets and end at the work area outlets.
 - 1. Routing:
 - a. Cables will be routed, in large groups, down main cable pathways, until a direct path to the point of access to the workstation outlet can be taken. At that point, cables will be routed, above all building systems, to the outlet location in accordance with standard installation practices, as described herein.
 - b. Multiple cables to individual rooms will be pulled as a bundle and terminated at each end in sequential order so that labeling within a room location is in sequence.
 - c. When not in conduit or tray, cables will be supported to the deck and/or beams. Hangers, clips, and other methods of grouping the cables and keeping them away from other systems installed in the building are to be provided and installed. Ensure that hangers and other methods of securing cable do not compress cable or damage insulation.
 - d. Cables hanger will be attached to beams prior to fire proofing applications and with minimal disruption of the fireproofing. The Contractor will be responsible for restoring the fireproofing to appropriate levels. Restoration will be verified by the General Contractor. Provide documentation that installation or restoration of fire stop systems is acceptable to Owner and PM.

- e. Cable routes will be with 90-degree angles whenever possible, following building lines. Cables will not be installed randomly or diagonally through the building.
 - f. Cables installed partially or fully within the telecommunications room will be routed through and secured in the cable tray wherever possible. No cables are to be routed across the rooms at angles, or are the cables to be run from one portion of the room or tray to another. Cables placed in the cable tray are to be laced frequently to keep them neatly bundled and not permitted to shift from one side of the tray to the other as they are routed in the tray.
 - g. Station cables will be routed to fixed wall locations through EMT to back box. Secure and store 24" of slack cable above ceiling at cable entrance to EMT.
2. Separation from EMI Sources:
- a. Comply with BICSI TDMM and TIA-569 recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment will be as follows:
 - c. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - d. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - e. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
 - f. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment will be as follows:
 - g. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - h. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - i. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
 - j. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures will be as follows:
 - k. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - l. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - m. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
 - n. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
 - o. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).
3. All cables will have both ends completely terminated at their respective patch panel and work area outlet. Individual conductors will be trimmed flush with IDC block.
4. The total length of permanently installed cable for any complete segment will not exceed 295 feet (90m). Do not splice or otherwise re-terminate any cable used, terminate only at the patch panels, cross connect blocks and work area outlets. Route cables [minimum of 12 inches (305mm) away] to avoid light ballasts, transformers, power wiring and other electrical devices so that there is no EMI or RFI interference with data transmission. Permanently label all cables six inches from the connector at each end, according to the numbering convention outlined in the section on labeling. All cables will be terminated at outlets, patch panels or cross-connect blocks ONLY.
5. Maximum pulling tension will not exceed 25 lbs./ft. when installing cables.

3.5 LABELING

- A. Backbone cabling will be labeled at all pull points and ends with water proof labels using the following color schedule:
1. Voice copper Backbone – white
 2. Data fiber Backbone – yellow
 3. FA fiber Backbone – red

3.6 FIRE STOPPING

- A. Labeling details will be provided by CLPCCD ITS at the Telecom Pre-Con meeting. Fire stopping
- B. Work, in general, includes furnishing and installing fire and smoke barrier penetration sealing systems for openings in floor, walls, and other elements of construction.
- C. Comply with requirements in Division 07 Section "Penetration Fire stopping".
- D. Comply with TIA/EIA-569-A, Annex A, "Fire stopping."
- E. Comply with BICSI TDMM, "Fire stopping Systems" Article.
- F. Applicator Qualifications: Two years of experience installing UL classified fire stopping.
- G. Performance of materials will have been tested to provide fire rating equal to that of the construction.
- H. Provide standard firestop details in shop drawings that are intended for use in this project for review and approval of relevant authority.

3.7 SHOP DRAWINGS:

- A. Submit complete shop drawings coordinated where required with work of other sections.
 - 1. Shop drawings shall include horizontal cabling and BDF/IDF information only.

3.8 SEALING OF PENETRATIONS AND OPENINGS

- A. All fire stop systems will be installed in accordance with the Manufacturer's recommendations and will be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.
- B. Where possible, utilize fire stop systems that have intumescent material built in as a part of the system.
- C. Where systems with built in intumescent material are not provided, provide a seal around raceways or cables penetrating full height walls (slab to slab), floors or ventilation or air handling ducts so that the spread of fire or products of combustion will not be substantially increased, and that also maintains partition's STC rating.
- D. Penetrations through fire-resistant-rated walls, partitions, floors or ceilings will be fire stopped using approved systems and methods and UL listed products to maintain the fire resistance rating.
- E. Installation restrictions of the listing agencies will be strictly adhered to {e.g. 24 inch (610 mm) minimum horizontal separation between boxes on opposite sides of the wall, maximum square inch opening in wall}.
- F. Fire stopping in sleeves or in areas having small openings that may require the addition or modification of installed cables or raceways will be soft, pliable, non-hardening fire stop putty. Putty will be water resistant and intumescent.
- G. Fire stopping in locations not likely to require frequent modification will be UL listed putty or caulk to meet the required fire resistance rating.

- H. Box penetrations into a fire rated wall or shaft will have a fire-stopping pad installed on the back of the box.
- I. Fire stopping of cable trays through walls will be with UL listed intumescent bricks to meet the required fire resistive rating and that will not allow products of combustion to pass through the protected opening. The UL listed bags will be installed inside and on both sides of the opening as required to meet the required resistive fire rating of the wall.
- J. Fire stopping materials will be UL listed to UL 1479 (ASTM E814). Installation methods will conform to a UL fire stopping system. Submit specifications and installation drawings for the type of material to be used. Fire stopping materials will be as manufactured by 3M, International Protective Coatings Corp., Specified Technologies, Inc., Carborundum Company, RayChem, Nelson Fire Stop or approved equal.

3.9 WARRANTY REQUIREMENTS

- A. Project Warranty
 - 1. Equipment and materials required for installation under these specifications shall be the current model and new (less than one [1] year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect for a minimum of one year from date of project's substantial completion.
 - 2. When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or Owner.
- B. Advanced System Warranty for Telecommunications (Copper and Fiber Systems)
 - a. This warranty shall to cover any material defect, as well as the performance of the cabling system. (Example: A Category 5e cabling system is to deliver 1000BASE-T speed, or 1 "Gig" performance for the entire length of the warranty period.)
 - b. This warranty shall cover both material and labor for the full length of the warranty period.
 - c. The Telecommunications Subcontract shall be certified by this manufacturer.
 - d. The following manufacturer is conditionally approved to provide the system warranties (subject to specific project requirements):
 - 1) Copper Connectivity Manufacturer
 - a) SYSTIMAX Category 6A cabling Infrastructure (Commscope)
 - 2) Fiber Connectivity Manufacturer
 - a) TeraSPEED Single Mode fiber, (Commscope)
 - 3) Cabling Manufacturer
 - a) SYSTIMAX Category 6A cabling Infrastructure (Commscope)

3.10 CABLE SUPPORTS

- A. Provide hook and loop (Velcro) cable wraps at all panels, equipment racks, cabinets and J-hook supports. Tie wraps are specifically prohibited.
- B. For horizontal cables, secure with minimum required compression in order to secure the cables properly without impeding the signal transmission rating (geometry) of the cable. Hook and loop (Velcro) cable wraps may be used in lieu of cable ties for copper cables only.
- C. Provide J-Hook supports from the building structure as required for cable runs to the cable drop location. Maximum distance between supports will be from 3.5 to 5.5 feet (with spacing randomly determined) depending on the structural elements of the building.
 - 1. Comply with maximum number of cables per support specified by manufacturer.

2. Provide additional supports as required when cable quantities exceed manufacturer's data, and to maintain required bending radius of cables.
3. Cables installed exposed, in areas below finished ceiling, or in inaccessible areas, shall be installed in conduit.
4. All J-Hooks supported by threaded rods only. **Drop-wires are not allowed.**

- D. All cables will be supported directly from building structure. Under no circumstance will cable be installed using cross bracing, plumbing/sprinkler pipes, ceiling systems or any other system that is not a specifically approved method to independently support cables. Cables will not be allowed to rest on ceiling tiles, duct work, piping, etc. Supports will be provided as required in order for cables to avoid contact with any other building system. Bundle cables in groups by Room.

3.11 CABLE PROTECTION

- A. Provide bushings in all metal studs and the like where cables will pass through. Bushings will be of two (2)-piece construction with one piece inserted through the opening and the second piece locking it into place. Single piece bushings with locking tabs or friction fit are specifically prohibited.
- B. Cables to be installed in existing enclosed open bays or furred spaces where conduit stubs are not provided, will be protected from chafing or any damage. The Installer will verify that the warranty will not be violated before installing any cabling in these locations.
- C. Provide cutting, coring, sleeves and bushings and seal as required at all penetrations.
- D. Cables damaged during installation will not be repaired. They will be completely replaced with new cable at no cost to the Owner.

3.12 GROUNDING & BONDING

- A. Refer to section 27 05 26 for Grounding and Bonding requirements.

3.13 DOCUMENTATION

- A. Label all equipment as herein specified.
- B. Provide:
1. Provide Building Structured Cabling Systems Administration Report indicating TIA/EIA-606 required information.
 2. Digital copies of test results for every cable segment. Documents will include measured values as well as whether or not the test passed.
 3. "Record" drawings indicating location of all equipment including but not limited to work area outlets, patch panels, cross connect blocks, on each segment and cable routing. Indicate labeling for each piece of equipment.
 4. Record drawings in digital format indicating actual cable routes and outlet identifiers. Provide respective copies mounted in each telecommunications room, and the main cross connect.
- C. Provide "as-built" Drawings on AutoCAD Version 12 or higher to the Owner in addition to .pdf copies. Obtain copy of original Drawings from the Architect.
- D. Submit UL certification that the structured cabling system meets the transmission requirements of TIA-568-C.0.

3.14 CLEANING

- A. In all telecom room spaces - a thorough sweeping, vacuuming and wet mopping shall be performed on a weekly basis or more frequently as directed by the owner. Cleaning shall include floors, rafters, floor joists, exposed structural members, exposed mechanical/electrical equipment and ductwork/piping/conduits, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, or per manufacturer recommendations.
- B. All cable managers and snap covers shall be wiped clean, both inside and outside of front, including rear channels. All clear covers and doors shall be cleaned, both front and rear per manufacturer recommendations.
- C. Inside of fiber optic enclosure and patch panels shall be blown clean of settled dust. Cleaning shall be performed for all new construction projects or where gypsum sanding has been performed.
- D. NOTE: During installation and prior to final handoff to Owner, keep all open fiber and copper ports covered utilizing plastic or tape that leaves no sticky residual.
- E. All scraps, boxes, spools, pull-line and trash shall be removed and properly disposed of.
- F. All residual cable lubricant shall be cleaned from floors and walls with an appropriate degreaser.

3.15 PROJECT CLOSEOUT

- A. Provide close out submittals as required herein and include the following close out submittals.
 - 1. Operation and Maintenance Manuals
 - 2. Record Drawings
 - 3. Test Reports
 - 4. Warranty certification from Manufacturer's
 - 5. Extra Materials
 - 6. Provide factory calibration report of field test equipment
- B. Obtain written receipts of acceptance close out submittals submitted. Receipts will specifically detail what is being delivered (description, quantity and specification section) and will be dated and signed by firm delivering materials and by the Owner's Representative.
- C. Provide As-Built drawings indicating actual cable routing and cable terminations including all required identifiers.
- D. All sketches, drawings, and charts herein are for the purpose of providing for specifications in a simplified format. Errors and omissions in such do not relieve the Contractor of the responsibility for providing a fully complete, secure and properly operating structured cabling system suitable for the intended use. Bidders must obtain a complete set of Project Drawings and Specifications to determine the full scope of work. In case of conflict, the Project Drawings and Specifications will prevail.

END OF SECTION

SECTION 27 0526 - COMMUNICATIONS GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section governs the products and execution requirements relating to furnishing and installing grounding and bonding for the communication systems, and supplements requirements found in related sections.
- B. Specifications and drawing package in its entirety, conditions set forth in base contract, exhibits, etc. as the items pertain to this project.
- C. Description of work:
 - 1. Furnish and install a complete and fully-functioning grounding and bonding system. All cables, terminations, support hardware, and grounding and bonding hardware shall be furnished, installed, tested, labeled, and documented by the telecommunications subcontractor.
 - a. Coordinate with electrical contractor including:
 - 1) Pathways, termination points, buss bar locations, and connections to the main electrical service ground and electrical distribution panels, conduit, fittings and bodies; bonding, Grounding cable and fittings; junction boxes; pull boxes; gutters; and measured pull tape.
- D. Related Sections:
 - 1. 270000: Communications
 - 2. 270810: Optical Fiber Testing and Measurement
 - 3. 270820: Copper Testing
 - 4. 271100: Communications Equipment Room Fittings
 - 5. 271300: Communications Backbone Cabling
 - 6. 271500: Communications Horizontal Cabling
 - 7. 271600: Communications Connecting Cords Devices & Adapters

1.2 ADDITIONAL INFORMATION

- A. Refer to Section 27 00 00 for Part 1 General information

1.3 RELATED DOCUMENTS

- A. The most recent versions of all related documents apply to this project.
- B. Comply with the following codes and standards:
 - 1. IEEE Standard 837 2002 – Standard for Qualifying Permanent Connections Used in Substation Grounding
 - 2. IEEE 142-2007 - (Green Book) - Recommended Practice for Grounding of IEEE 142-2007 - (Green Book) Industrial and Commercial Power Systems
 - 3. IEEE 1100 – 2005 - (Emerald Book) - Recommended Practice for Powering and Grounding Electronic Equipment
 - 4. IEEE Standard 1100 - IEEE Recommended Practice for Powering and Grounding Electronic Equipment (Emerald Book)
 - 5. Telecommunications Industry Association TIA-569-B-2004 Commercial Building Standard for Telecommunications Pathways and Spaces.

6. American National Standards Institute ANSI J/STD-607-A-2002 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
 - C. The following guidelines shall be followed:
 1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
 2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
 3. The following related project specifications shall be followed:
 4. Specification 27 00 00 Communications
 - D. References:
 1. American National Standards Institute (ANSI):
 - a. C80.1 Rigid Steel Conduit – Zinc Coated.
 - b. C80.4 Fittings for Rigid Metal Conduit.
 - E. Federal Specifications (FS):
 1. W-C-58C Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron.
 2. W-C-1094 Conduit and Conduit Fittings Plastic, Rigid.
 3. WW-C-566C Flexible Metal Conduit.
 4. WW-C-581D Coatings on Steel Conduit.
 - F. National Electrical Manufacturers Association (NEMA):
 1. RN1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Electrical metallic Tubing.
 2. TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
 3. TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 4. NEMA VE 1 – Metal Cable Tray Systems.
 5. NEMA VE 2 – Metal Cable Tray Installation Guidelines.
 - G. American Society for Testing and Materials International (ASTM):
 1. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 2. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Gal annealed) by the Hot-Dip Process.
 3. ASTM B633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - H. Underwriters Laboratories Inc. (UL):
 1. 6 Rigid Metal Electrical Conduit.
 2. 514 B Fittings for Conduit and Outlet Boxes.
 3. 651 Schedule 40 and 80 Rigid PVC Conduit.
 4. 651A Type EB and A Rigid PVC Conduit and HDPE Conduit.
 5. 1666 Standard for Riser Application for Optical Fiber Raceway.
 - I. Local, county, state and federal regulations and codes in effect as of date of purchase.
 - J. Equipment of foreign manufacture must meet U.S. Codes and standards. It will be indicated in the proposal the components that may be of foreign manufacture, if any, and the country of origin.
- 1.4 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
- A. The publications listed herein form a part of this specification. The publications are referred to in the text by basic designation only.
 - B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies will mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.

- C. Conflicts:
1. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements or greater quantity as per context of the document.

1.5 SUBMITTALS

- A. The Contractor will perform no portion of the work requiring submittal and review of record drawings, shop drawings, product data, or samples until the respective submittal has been approved by the Owner. Such work will be in accordance with approved submittals.
- B. Qualifications: The Contractor will submit qualification data sheets for firms and persons as specified in the "Quality Assurance" article of this specification to demonstrate their capabilities and experience.
- C. Proposed product data sheets: The Contractor will submit catalog cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number will be handwritten and/or highlighted to indicate exact selection. Identify applicable specification section reference for each product.
- D. The following submittals are due at the Pre-Construction Phase, in accordance with submittal requirements in Section 27 00 00 Communications:
1. Product Information
 - a. Provide manufacturer's product information cut-sheet or specifications sheet with the specific product number identified.
 2. Shop Drawings
 3. Provide scaled drawings (floor plans not less than 1/16" = 1'-0") indicating the location and size, dimensions, type of connection (e.g., mechanical, exothermic weld of each bonding buss bar (e.g., TMGB, TGB), conductor (e.g., BCT, GE, TBB), connections (e.g., lugs), and splice points.
 4. Provide scaled plan and elevation drawings of telecommunications rooms (not less than 1/4" = 1'-0") indicating locations of buss bar (e.g., TMGB, TGB, UBC, RGB).
 5. Bonding and Grounding shall have its own separate drawing(s).
- E. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
1. As-Built Drawings
 2. Furnish CAD drawings of completed work including cable ID numbers following the Owner's labeling standards. Submit in hardcopy (two full size and two half size) and electronic formats:
 - a. Provide scaled drawings (floor plans not less than 1/16" = 1'-0") indicating actual location and size/length of TMGB, TGBs, BCT, GE and TBB conductors and all splice points.
 - b. Provide scaled plan and elevation drawings of telecommunications rooms (not less than 1/4" = 1'-0") indicating actual locations of TMGB and TGBs.
 - c. Bonding and Grounding shall have its own separate drawing(s).
 3. Manufacturer and Maintenance Manuals for all installed equipment. This is to include:
 - a. Manufacturer specification sheets (cut sheets) and installation instructions/manuals for all installed products.
 4. A letter from the contractor Project RCDD stating that the grounding system has been installed in accordance with the project documents and the referenced codes, standards, and guidelines. This letter is to also specifically acknowledge that the telecommunications grounding system has been fully tested according to these specifications. The required contents of this letter may be incorporated into the letter required from the Project RCDD in section 27 00 00.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

1.7 COORDINATION

- A. The Electrical Contractor shall furnish and install telecommunications grounding buss bar, telecommunications bonding backbone(s), grounding equalizer(s), and equipment bonding conductors to install a complete telecommunications grounding system.
- B. Field coordinate installation of conduit and cable with other trades to ensure clearance requirements are met.
- C. Coordinate with all contractors providing equipment outside the scope of this contract.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All components shall be listed by a NRTL.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work are included in each product type, but are not limited to those listed.

2.2 TELECOMMUNICATIONS MAIN GROUNDING BUSS BAR (TMGB)

- A. Provide a telecommunications main grounding buss bar (TMGB) at the telecommunications service entrance (or as indicated on the drawings).
- B. The TMGB shall:
 - 1. Be a predrilled copper buss bar with holes for use with correctly matched Listed lugs and hardware.
 - 2. Have minimum dimensions of 0.25" thick by 4" wide by 20" long. Increase length as necessary to provide all connections plus 25% spare capacity.
 - 3. Be listed by a NRTL.
 - 4. Be manufactured by:
 - a. Chatsworth P/N 40153-020
 - b. Or approved alternate

2.3 TELECOMMUNICATIONS GROUNDING BUSS BAR (TGB)

- A. Provided a telecommunications grounding buss bar (TGB) in each telecommunications room.
- B. The TGB shall:
 - 1. Be a predrilled copper buss bar with holes for use with correctly matched listed lugs and hardware.

2. Have minimum dimensions of 0.25" thick by 4" wide by 10" or 12" long. Increase length as necessary to provide all connections plus 25% spare capacity.
3. Be listed by a NRTL.
4. Be manufactured by:
 - a. Chatsworth P/N 40153-012
 - b. Or approved alternate

2.4 BONDING CONDUCTOR FOR TELECOMMUNICATIONS (BCT)

- A. BCT shall:
 1. Be copper must be insulated with green insulation
 2. Be Listed for the application when insulated.
 3. As a minimum, the same size as the largest TBB.
- B. The manufacturer shall be:
 1. Harger
 2. Or approved equivalent

2.5 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- A. The TBB shall:
 1. Be copper and may be insulated.
 2. Be Listed for the application when insulated.
 3. Be sized at 3 kcmil per linear foot of conductor length up to a maximum size of 750 kcmil.

2.6 RACK BONDING CONDUCTOR (RBC)

- A. An RBC shall:
 1. Be copper and may be insulated.
 2. Be Listed for the application when insulated.
 3. Be sized as a No. 6 AWG.
- B. The manufacturer shall be:
 1. Harger
 2. Or approved equivalent

2.7 RACK GROUNDING BUSS BAR (RGB)

- A. Description: grounding Strip for 2-post and 4-post Communications Racks.
- B. A RGB shall:
 1. Be wrought copper and tin plated.
 2. Be capable of supporting multiple unit bonding conductors.
 3. Be Listed.
- C. The manufacturer shall be:
 1. Harger
 2. Panduit, Grounding Strip Kit, RGS134-1Y
 3. Or approved equivalent

2.8 GENERAL BONDING CONDUCTORS OR JUMPERS

- A. Provide and install general bonding conductors and jumpers per construction documents. Refer to drawings and execution section for required locations.

- B. For all conductors and jumpers connecting equipment located in the same room as the TMGB/TGB, conductors/jumpers shall be in a green insulated jacket. This jacket shall include markings that indicate conductor size (minimum of #6 AWG), manufacturer and UL listing.
- C. Manufacturer shall be:
 - 1. Harger
 - 2. Panduit
 - 3. Or approved equivalent

2.9 BONDING ACCESSORIES

- A. Grounding Lugs
 - 1. Shall be Listed for the application.
 - 2. Shall be two holes compression crimp with inspection window, unless otherwise noted.
 - 3. Copper or tin plated copper.
 - 4. Manufacturers shall be:
 - a. Erico, Cadweld Telecom Lugs
 - b. Harger
 - c. Framatome Connectors/Burndy Electrical.
 - d. Panduit
 - e. Or approved equivalent
- B. Unit Bonding Conductor (UBC)
 - 1. Shall be Listed for the application.
 - 2. Shall be a minimum No. 12 AWG
 - 3. Copper with 90-degree bent lugs installed.
 - 4. Manufacturers shall be:
 - a. Erico, Cadweld Telecom Lugs
 - b. Harger
 - c. Panduit
 - d. Or approved equivalent

2.10 MATERIALS

- A. All conduits, fittings, junction and pull boxes will be UL rated.
- B. All conduits, fittings, junction and pull boxes will comply with the NEC.
- C. PVC-Coated Rigid Steel Conduit and Fittings: Follow NEMA RN1 (Type A).
- D. Non-metallic Conduit and Fittings: Pass NEMA TC2, UL 651 and 651A and FS W-C- 1094A. EMT fittings will be formed steel compression ring type. Die cast fittings are not allowed.
- E. Rigid Steel Galvanized Conduit and Fittings Before Coating
 - 1. Follow FS WW-C-581d, ANSI C80.1, and UL 6.
 - 2. Pass bending, ductility, and thickness of zinc coating in ANSI C80.1.
- F. Electrical Metallic Tubing (EMT):
 - 1. EMT fittings will be formed steel compression ring type. Die cast fittings are not allowed.
 - 2. EMT will be UL listed and conform to NEC Article 300.22.
 - 3. Will be used inside buildings only.
 - 4. Only manufacturer's fittings, transition adapters, terminators and fixed bends will be used.
 - 5. All transition junction and pull boxes, fittings terminators and adapters will be a metallic material.
 - 6. Minimum average tensile strength will be 1250 lbs. For 1½-inch and smaller conduits and inner duct.

7. Minimum average tensile strength will be 1800 lbs. For conduits larger than 1½ inch.
- G. Conduit Bodies: Follow UL 514B and FS W-C-58C. Furnish sufficient coating for touch up after installation.
- H. Conduit Fittings
 1. All fittings will be compression or threaded.
 2. Fittings will provide a secure connection for pulling communications cables.
 3. Setscrew fittings are not permitted.
- I. Conduit “condulets” are not permitted. Smart LB’s are permitted.
- J. Flexible conduit is not permitted.
- K. Non-metallic conduits are not permitted in above ground installations. Conversion fittings are required for non-metallic (below ground) to metallic (above ground) transitions.
- L. Buss bars:
 1. Electrolytically-plated for reduced contact resistance
- M. Telecommunications Bonding Backbone (TBB)
 1. All Telecommunications Bonding Backbone (TBB) Cables will be insulated and installed in conduit between manholes, telecommunications closets, building steel frame and building electrical grounding system.
 2. TBB cables will interconnect all Telecommunications Grounding Buss bar (TGB) with the Telecommunications Main Grounding Buss bar (TMGB). The TBB will originate at the TMGB and extend throughout the building and connects to all the TGB’s in telecommunications closets and equipment rooms.
 3. The TBB will be installed without splices, where practicable
 4. Joined segments (conductors to buss bars) will be connected using irreversible connectors such as exothermic welding or equivalent.
 5. The TBB will be sized per table below. The TBB from TGB to the panel board in the same telecommunications space will be No. 6 AWG. All TBB connections to the TGB will utilize exothermic weld connectors.
 6. Approved bonding (Exothermic welds or double lug crimp) will be used to connect TBB from TMGB or TGB and building steel frame. All other connections will use 2-hole compression connectors.
 7. UL Listed with Flame Propagation compliant with UL 2024.
- N. Antioxidant Joint Compound for use with copper to copper bonding
 1. Approved manufacturer: Harger P/N HCAJC8
- O. Pull Boxes, Junction Boxes and Gutters
 1. All junction boxes, gutters and pull boxes will comply with NEC Article 314.
 2. All junction boxes, gutters and pull boxes will meet the following minimum material requirements:
 - a. 16-gauge steel or heavier.
 - b. Seams will be continuously welded and ground smooth.
 - c. External screws and clamps.
 - d. External mounting feet (where possible).
 - e. Oil-resistant gasket and adhesive.
 - f. ANSI 61 gray polyester powder coating inside and out over phosphatized surface.
 - g. UL 50 type 12.
 3. All junction boxes, gutters and pull boxes will be provided with bushings for conduits and/or cabling.
 4. All junction boxes, gutters and pull boxes will be securely installed.

5. All junction boxes, gutters and pull box sizes for single and multiple conduit runs will comply with BICSI TDMM.
6. All bonding conductors and connectors will be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL).
7. All bonding conductors will be insulated and copper. The minimum bonding conductor size will be a No. 6 AWG.

PART 3 - EXECUTION

3.1 GENERAL

- A. Locate TMGB and TGBs so that they are permanently accessible to telecommunications personnel.
- B. At a minimum, follow all manufacturer instructions. In case of discrepancy between manufacturer and contractor requirements, the more stringent shall apply. In the case of conflicting instructions, report any discrepancy to the Design Engineer in a timely fashion so as not to impact the construction timeline.
- C. At a minimum, provide exothermic welds as identified on the drawings or required in the specifications. For all other connections, irreversible compression connections are sufficient.
- D. Identification
 1. All telecommunications grounding and bonding conductors shall be labeled within 6" of each end. Labels shall be nonmetallic and read as follows:

IF THIS CONNECTOR OR CABLE IS FOUND TO BE
LOOSE OR MUST BE RECONFIGURED OR REMOVED,
PLEASE CALL THE BUILDING
TELECOMMUNICATIONS MANAGER PRIOR TO ANY
FURTHER WORK

- E. Testing
 1. All grounding connections shall be tested for continuity and resistance after installation but prior to substantial completion. Refer to drawings for grounding riser and test measures. The telecommunications contractor is to invite the Design Engineer and ITS representative to witness a portion of this testing while it is being performed.
 2. The test performed shall use an earth ground resistance tester that is configured for a continuity test otherwise known as a two-point test or a "dead earth" test. Tests shall be conducted between the electrical entrance ground and the TMGB as well as at each TGB. This resistance shall be less than 0.05Ohms.
 3. Coordinate with the electrical installer for the test of the Building's Grounding Electrode System and its resistance at earth. It is recommended that this resistance measure be equal to or less than 5 ohms. Include in the grounding test report the measured resistance at the Building's Grounding Electrode System as reported by the entity performing the test.

3.2 TMGB

- A. All metallic raceways for telecommunications cabling located within the same room or space as the TMGB shall be bonded to the TMGB.

- B. Insulate the TMGB 2" from the wall.
- C. For outside plant cables entering a building with a cable shield isolation gap, bond the cable shield (on the building side of the gap) to the TMGB. Outside plant protectors shall be bonded to the TMGB with a No. 6 AWG conductor.
- D. Connections to the buss bar shall be made with 2-hole lugs.
- E. Connections shall be made by cleaning the area of connection on the buss bar and on the two-hole lug and then applying a thin coating of anti-oxidant compound.

3.3 TGB

- A. All metallic raceways for telecommunications cabling located within the same room or space as the TGB shall be bonded to the TGB.
- B. Insulate the TGB 2" from the wall.
- C. Connections to the buss bar shall be made with 2-hole lugs.
- D. Connections shall be made by cleaning the area of connection on the buss bar and on the two-hole lug and then applying a thin coating of anti-oxidant compound.

3.4 BCT

- A. Route BCT in conduit from telecommunications service entrance room to the main electrical service ground connection.
 1. Label conduit at telecommunications service entrance with tag or adhesive label that states "Building Conductor for Telecommunications (BCT) to Main Electrical Service Ground Connection".
 2. Label conduit at main electrical service ground connection with tag or adhesive label that states "Building Conductor for Telecommunications (BCT) to Telecommunications Main Grounding Buss bar (TMGB)".
 3. BCT shall not be run in a metallic conduit and shall not be completely encircled by metallic clamps.

3.5 TBB

- A. Where following the same routing as cable tray, attach TBB on the outer side of the cable tray to minimize contact with communications cabling.
- B. Size the grounding conductors according to the following table, except as it varies in the grounding riser diagram:

Sizing of the BCT & TBB	
TBB Length in Linear meters (feet)	TBB Size AWG
Less than 4 (13)	6 (16mm ²)
4-6 (14-20) 4	4 (25mm ²)
6-8 (21-26)	3 (25mm ²)
8-10 (27-33)	2 (35mm ²)
10-13 (34-41)	1 (35mm ²)
13-16 (42-52)	1/0 (50mm ²)
16-20 (53-66)	2/0 (70mm ²)
20 – 26 (67 – 84)	3/0 (85mm ²)

26 – 32 (85 – 105)	4/0 (107 mm ²)
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

3.6 GENERAL BONDING CONDUCTORS OR JUMPERS

- A. General bonding conductors or jumpers are to be utilized in each telecommunications room between the TMGB/TGB and the following components:
1. The communications building entrance protectors.
 2. Electrical panel board (if in same room as TMGB/TGB).
 3. Building steel (if available in same room as TMGB/TGB).
 4. Telecommunications ladder rack and cable tray.
 - a. Bonding jumpers are to be utilized to ground adjacent pieces of ladder rack and cable tray together, reducing the need to a single conductor back to the TMGB/TGB.
 - b. In cases where ladder rack or cable tray is painted, prepare each section by removing paint at the connection point to ensure a completely bonded connection. If the contractor believes this is not necessary, submit documentation from manufacturer indicating NRTL testing was done in regard to grounding without removal of the paint.
 5. Telecommunications equipment racks and cabinets.
 - a. Each cabinet and rack shall be bonded to the TMGB/TGB by bonding to the row's bonding conductor with a #6 AWG RBC from the Rack Grounding Buss bar (RGB). All conductors are to be of equal length and bonded with non-reversible bonds.
 - b. In cases where racks or cabinets are painted, prepare each item by removing paint at the connection point to ensure a completely bonded connection. If the contractor believes this is not necessary, submit documentation from manufacturer indicating NRTL testing was done in regard to grounding without removal of the paint.
 - c. Bond adjacent racks and cabinets in an approved manner with # 6 AWG insulated green conductor.
 - d. Telecommunications Equipment Bonding Conductor (TEBC) bonds components within a rack or cabinet to a rack buss bar. Install a minimum of # 12 AWG insulated green conductor.
- B. Row bonding conductor
1. Install the rack or cabinet row bonding conductor sized as indicated on bonding riser and bonding detail.
 2. The default size for row bonding conductors is # 2/0 AWG.
 3. Bond to the RBC from the rack bonding jumper such that the bond of the rack jumper is laid in the direction of (or pointed to) the buss bar.

3.7 GROUNDING LUGS

- A. Wires shall be inserted to the full depth of the lug.
- B. Space between wire insulation and the body of the compression lug shall be kept to a maximum of 1/4 inch.
- C. Lug must agree with wire size.

- D. To assure proper die is used with the specified connector, manufacturer's embossed coding systems shall be adhered to.
- E. Connectors shall not be modified in any way.
- F. Daisy chaining and stacking (piggy backing) of ground lugs is prohibited.
- G. Bolts, nuts, washers used to secure ground connections shall match the diameter of the hole.

3.8 PREPARATION

- A. Contractor's on-site RCDD supervisor will review, approve and stamp all shop drawings, coordination drawings and record drawings.
- B. Verify conduit system is properly sized for cables (minimum one inch, unless otherwise noted in Drawings).
- C. Verify general conduit route following Drawings.
- D. Verify substrates to which work is connected and determine detail requirements for proper support.
- E. Verify proper location and type of rough-in for conduit, cable terminations and ground buss bar.
- F. Clean and wipe off all lugs from any oils or other debris prior to utilization.

3.9 INSTALLATION

- A. Coordinate locations with other trades prior to installation.
- B. Install work following drawings, manufacturer's instructions and approved submittal data.
- C. Installation plans and requests for information (RFIs) will be reviewed by contractor's on-site RCDD.
- D. All work will be supervised and reviewed by contractor's on-site RCDD.
- E. Check all bonds for loose connections in walk-thru prior to testing system.
- F. Test bonding of system for all metallic components back to buss bar for conformance to a 0.01 ohms maximum resistance.
- G. Locations and Types:
 - 1. Install PVC coated conduits in outdoor above-ground locations, inside valve vaults and wet wells, and in corrosive and wet environments.
 - 2. Install PVC conduits in buried duct banks or encased in concrete. Use PVC coated rigid steel for footing, slab, or other stub-outs.
 - 3. Install exposed conduit parallel or perpendicular to lines of existing construction and grouped together where possible, without interfering with use of premises or working areas. Prevent safety hazards and interference with operating and maintenance procedures.
 - 4. Conduit may pass through areas with temperature differential of 20 degrees F or more. Seal with proper fitting at barrier between areas of differing temperature.
 - 5. Do not install conduit in interference with equipment placement or operation; piping; structural members; maintenance access; indicated future equipment.

6. Contractor's RCDD supervisor will coordinate with drawings of other disciplines to determine availability of space for installation.

H. Design Considerations

1. Conduit fill will comply with ANSI/TIA/EIA-569-C.
2. The minimum bend radius is ten (10) times the conduit outside diameter (OD) for conduits 2" and greater.
3. Below grade conduit will extend four inches above finished floor (AFF) with a bushing.
4. Ceiling conduit or sleeves will extend six inches below finished ceiling with a bushing.
5. All stubbed conduit ends will be provided with a ground bushing.
6. All conduit penetrations will comply with all applicable fire codes. All conduit penetrations in fire-rated walls or floors will be sealed and fire proofed to at least the rating of the penetration area.
7. Conduits will be routed in the most direct route, with the fewest number of bends possible.
8. There will be no continuous conduit sections longer than 100 feet. For runs that total more than 100 feet, insert junction or pull boxes (or gutters if appropriate) so that no continuous run between pull boxes is greater than 100 feet.
9. There will be no more than two 90-degree bends (180 degrees total) between conduit pull boxes.
10. Changes in direction will be accomplished with sweeping bends observing minimum bend radius requirements above. Do not use pull boxes for direction changes unless specifically designated otherwise in the Drawings.
11. Unless otherwise noted in the Drawings, conduits entering pull boxes will be aligned with exiting conduits.

I. Telecommunication Bonding Backbone (TBB) Installation

1. Comply with ANSI/TIA/EIA-607.
2. TBB placed in ferrous metallic conduit that exceeds 1m(3 ft.) in length, will be bonded to each end of the conduit with a conductor sized as a NO. 6AWG, minimum.
3. The TBB conductor for telecommunications will bond the TMGB to the service equipment (power) ground.

J. Antioxidant Joint Compound for use with copper to copper bonding

1. Utilize for copper to copper connections, copper threads and all grounding/bonding applications

K. Identification: Refer to Section 27 00 00 for labeling requirements.

3.10 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and the Owner is satisfied that all work has been completed in accordance with contract documents, the Owner will notify Contractor in writing of formal acceptance of the system.

- B. Acceptance will be subject to completion of all work and submittal and approval of complete as-built documentation as described above, and MAA final inspection of the work for compliance with the approved as-built documentation.

END OF SECTION

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. 2.2 Ladder cable trays.
 - 2. 2.3 Wire-basket cable trays.

- B. Related Requirements:
 - 1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
 - 2. Shop Drawings: For each type of cable tray.
 - 3. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including velcro fasteners, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 4. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - 5. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 6. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

- B. INFORMATIONAL SUBMITTALS
 - 1. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 2. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 3. Vertical and horizontal offsets and transitions.
 - 4. Clearances for access above and to side of cable trays.
 - 5. Vertical elevation of cable trays above the floor or below bottom of ceiling structure
 - 6. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
 - 7. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 8. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 9. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 10. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
 - 2. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- B. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, CPI ladder racking (Chatsworth)
- C. Description:
 - 1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
 - 2. Rung Spacing: 6 inches, 9 inches, 12 inches, 18 inches o.c., as appropriate for installation
 - 3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
 - 4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
 - 5. No portion of the rungs shall protrude below the bottom plane of side rails.
 - 6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
 - 7. Minimum Usable Load Depth: 4 inches.
 - 8. Straight Section Lengths: 10 feet, 12 feet, 20 feet or 24 feet except where shorter lengths are required to facilitate tray assembly.
 - 9. Width: 12 inches, 18 inches, 24 inches or 36 inches unless otherwise indicated on Drawings.
 - 10. Fitting Minimum Radius: 12 inches
 - 11. The maximum uniform load and the support span are indicated by the cable tray class.
 - 12. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - 13. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316
 - 14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.3 BASKET CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- B. Basis-of-Design Product: Legrand Cablofil
- C. Description:
1. Configuration: Wires are formed into a wire grid pattern sufficient to support the loads intended.
 2. Materials: Metallic wire.
 3. Safety Provisions: All wire ends are to be deburred during manufacturing to maintain integrity of cables and installer safety.
 4. Sizes: As indicated on plans
 5. Maximum Loads: Not to exceed manufacturer stated load limits.
 6. Connector/Splicing Assemblies: Use splice plates, CMS model CM 801-SP or functional equivalent to join each tray section to the next tray section-or to intersections.
 7. Connector/Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray. Splices shall effectively act as a means to continue the bond from one tray section to the next tray section or tray intersection.
 8. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. If more than one cable tray cover type is required, delete "Covers" Paragraph below and indicate type on Drawings or in a schedule. Retain paragraph if cable tray covers are required. See "Cable Tray Covers" Article in the Evaluations.
- C. Indicate required locations for barrier strips on Drawings.
- D. Barrier Strips: Same materials and finishes as for cable tray.
- E. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

- F. Fasten cable tray supports to building structure and install seismic restraints as required by the structural engineer of record.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- M. Support wire-basket cable trays directly from threaded rods or with trapeze hangers. Refer to structural drawings for mounting and bracing requirements.
- N. Support trapeze hangers for wire-basket trays with minimum 3/8-inch- diameter rods or as indicated by structural engineer of record.
- O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- Q. Make changes in direction and elevation using manufacturer's recommended fittings.
- R. Make cable tray connections using manufacturer's recommended fittings.
- S. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- T. If cable trays are sized for future cables, specify provisions for penetrations with sleeves through fire-rated partitions or use "repairable" firestop-sealing material. Include this Section's specific firestopping requirements in a schedule developed in Section 078413 "Penetration Firestopping."
- U. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- V. Install cable trays with a minimum of 24" of clearance above the tray and 24" of clearance on one sides.

- W. Cable trays are for the exclusive use of telecommunications cabling. Other cabling system must provide their own independent pathway.
- X. See "Cable Tray Covers" Article in the Evaluations.
- Y. Install permanent covers, if used, after installing cable. Install cover velcro fasteners according to NEMA VE 2.
- Z. Velcro fasteners covers on cable trays installed outdoors with heavy-duty velcro fasteners.
- AA. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fastening cables on horizontal runs is beyond the requirements of NFPA 70 in most cases. See Evaluations.
- C. Fasten cables on horizontal runs with cable velcro fasteners or cable ties according to NEMA VE 2. Tighten velcro fasteners only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- D. Fasten cables on vertical runs to cable trays every 18 inches.
- E. Length of unsupported cable is dependent on the cable diameter. See "Cable Installations" Article in the Evaluations.
- F. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

- G. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.
- H. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Retain "Perform the following tests and inspections" Paragraph below to require Contractor to perform tests and inspections.
- B. Perform the following tests and inspections in-field:
 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 7. Check for improperly sized or installed bonding jumpers.
 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
 10. Prepare test and inspection reports and furnish to design team

3.6 PROTECTION

- A. Protect installed cable trays and cables.
- B. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

- C. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
- D. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 27 0810 - OPTICAL FIBER TESTING AND MEASUREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Products and execution requirements relating to testing and documentation for optical fiber cabling for the communication systems, and supplements requirements found in related sections.

1.2 WORK INCLUDED

- A. Provide all labor, materials, tools, field-test instruments, and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.
- B. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- C. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.

1.3 SCOPE

- A. This Section includes the minimum requirements for the test certification, identification and administration of backbone and horizontal optical fiber cabling.
- B. This Section includes minimum requirements for:
 - 1. Fiber optic test instruments
 - 2. Fiber optic testing
 - 3. Identification
 - a. Labels and labeling
 - 4. Administration
 - a. Test results documentation
 - b. As-built drawings
- C. Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR).
- D. Testing shall be performed on each cabling link (connector to connector).
- E. Testing shall be performed on each cabling channel (equipment to equipment) that is identified by the owner.
 - 1. Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

- F. All tests shall be documented including OLTS dual wavelength attenuation measurements for singlemode links and channels and OTDR traces and event tables for singlemode links and channels.
 - 1. Optionally documentation shall also include optical length measurements and pictures of the connector end face.

1.4 RELATED DOCUMENTS

- A. Specifications and drawing package in its entirety, conditions set forth in base contract, exhibits, etc. as the items pertain to this project.
- B. Related Sections:
 - 1. 270000: Communications
 - 2. 270526: Grounding and Bonding of Communication Systems
 - 3. 270820: Copper Testing
 - 4. 271100: Communications Equipment Room Fittings
 - 5. 271300: Communications Backbone Cabling
 - 6. 271500: Communications Horizontal Cabling
 - 7. 271600: Communications Connecting Cords Devices & Adapters

1.5 DEFINITIONS

- A. See Section 270000

1.6 QUALITY ASSURANCE

- A. Comply with testing procedures and field-test instruments in the applicable requirements of:
 - 1. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
 - 2. TIA -526-7-A, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
 - 3. IEC 61300-3-35, Automated End Face Grading
- B. Field Testing review by owner or owner's representative
 - 1. Provide notification a minimum of five (5) business days prior to field-testing start date
 - 2. A random test sample of the installed links will be compared to contractor supplied test results, if more than 2% of the sample deviates from the contractor's results, the contractor shall repeat 100% of the testing.
- C. Testing technicians shall be certified in fiber optic testing including OLTS and OTDR test equipment from an industry manufacturer or industry training organization such as BICSI.

1.7 SUBMITTALS

- A. Technician training certifications for fiber optic testing
- B. Manufacturers data sheets and specifications for the fiber optic field-test instruments including:
 - 1. OTDR
 - 2. OLTS
 - 3. Endface inspection capture device
- C. Sample test reports.

- D. A schedule (list) of all optical fibers to be tested.
- E. Manufacturer factory cable spec sheet and test results for fiber shipped.

1.8 CLOSEOUT SUBMITTALS

- A. Provide test data archive for future maintenance and establish the fiber optic plant baseline.
 - 1. Test shall be organized by media in binders with index and pagination.
 - 2. Field-instrument test results documentation
 - a. Provide electronic raw and unaltered data files from the field-test instrument
 - b. Provide the viewing software for the above file.
 - 3. Submit a spreadsheet in hardcopy and in an electronic file format acceptable to the owner.
 - a. Convert raw data files from the field-test instruments into an archiving utility spreadsheet for the maintenance, and inspection test records.
 - b. Provide the following information about the test in the spreadsheet:
 - 1) Site name as specified by the owner
 - 2) The standard selected to execute the test results
 - 3) Test date
 - 4) Manufacturer, model and serial number of the field-test instruments
 - 5) Version of the test software and the version of the test standards database in the test instrument
 - 6) OLTS Mandel sizes used for each cable type
 - 7) Index of refraction value used for length calculations
 - 8) Names of people performing the testing
 - c. Provide the following information for each tested optical fiber in the spreadsheet:
 - 1) Fiber identification number
 - a) If this number varies from the cable label, provide a cross reference.
 - 2) Length for each optical fiber calculated by the OLTS
 - 3) Length for each optical fiber calculated by the OTDR
 - 4) Automated End Face Grading
 - 5) Test results to include OLTS attenuation link and channel measurements at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value).
 - 6) Test results shall be submitted to include OTDR link and channel traces and event tables at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value).
 - 7) A picture or image of each fiber end-face.
 - 8) The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements.

1.9 TESTING RESULTS

- A. Link attenuation measurement and calculation
 - 1. Link attenuation calculation allowance = Cable Attenuation Allowance (dB) + Connector Insertion Loss Allowance (dB) + Splice Insertion Loss Allowance (dB) where:
 - a. Connector Insertion Loss Allowance (dB) = Number of Connector Pairs × 0.4dB
 - b. Splice Insertion Loss Allowance (dB) = Number of Splices × 0.15dB
 - c. Cable Attenuation Allowance (dB) = Maximum Cable Attenuation Coefficient (dB/km) × Length (km)

Optical fiber and cable type	Wavelength (nm)	Maximum attenuation (dB/km)
Singlemode Indoor-Outdoor (OS2)	1310	0.5
	1550	0.5
Singlemode Inside Plant (OS2)	1310	1.0
	1550	1.0
Singlemode Outside Plant (OS2)	1310	0.5
	1550	0.5

Table 1-1 Optical fiber cable attenuation performance (Ref. TIA-568-C.3 Table 1)

- B. Field testing cabling links
 - 1. Correct any fiber links that fail attenuation measurement and allowance calculation, or OTDR analysis.
 - 2. Document all corrective action.
 - 3. Retest all failed fiber links after corrective action.
 - 4. Provide testing documentation for corrected fiber links.

- C. Evaluate Individual connector, splice and fiber insertion loss using the OTDR trace and ensure these components meet or exceed the values in table 1-1.

PART 2 - PRODUCTS

2.1 OPTICAL FIBER CABLE TESTERS

- A. Ensure the field-test instrument is updated to the most recent software and firmware provided by the manufacturer prior to testing.

- B. Optical loss test set (OLTS)
 - 1. Calculate the length of fiber links
 - 2. Singlemode optical fiber light source
 - a. Provide dual laser light sources with central wavelengths of 1310 nm (± 20 nm) and 1500 nm (± 20 nm)
 - b. Output power of -10 dBm minimum
 - 3. Power Meter
 - a. Provide 850 nm, 1300 nm, 1310 nm, and 1500 nm wavelength test capability
 - b. Power measurement uncertainty of ± 0.25 dB
 - c. Store reference power measurement
 - d. Store a minimum of 100 results in internal memory
 - e. External computer interface (serial or USB)
 - 4. Acceptable Equipment:
 - a. Fluke Networks, CertiFiber Pro
 - b. Fluke Networks, DSX 5000 Cable Analyzer with all associated modules
 - c. Exfo, MaxTester 940
 - d. Approved equivalent

- C. Optical Time Domain Reflectometer (OTDR)
 - 1. Shall have a color transmissive LCD display with backlight
 - 2. Rechargeable Li-Ion battery for 8 hours of normal operation
 - 3. Internal non-volatile memory and removable memory device with at least 16 MB capacity for results storage

4. Serial and USB ports to transfer data to an external computer
 5. Single-mode OTDR
 - a. Wavelengths of 1310 nm (± 25 nm) and 1550 nm (± 30 nm)
 - b. Event dead zones typically of 1 m at 1310 nm and 1 m at 1550 nm
 - c. Attenuation dead zones typically of 8 m at 1310 nm and 8 m at 1550 nm
 - d. Distance range at least 60 km
 - e. Dynamic range 26 dB at 1310 nm and 24 dB at 1550 nm
 6. Acceptable Equipment:
 - a. Fluke Networks, OptiFiber Pro
 - b. Corning Cabling Systems, OV-1000 OTDR
 - c. Exfo, FTB-150 OTDR
 - d. Approved equivalent
- D. Fiber Video Scope
1. Field of view at least 250 μ m
 2. Video camera and display showing magnified end-face image.
 3. Camera probe tips permitting inspection through adapters.
 4. Electronic storage of end-face image.
 5. Acceptable Equipment:
 - a. Fluke Networks, Versiv (CertiFiber Pro, OptiFiber Pro or FI-7000)
 - b. Exfo MaxTester 940
 - c. Approved equivalent
- E. Fiber Cleaning Products
1. Optical-grade cleaning fluids that leave no residue and are fast-evaporating
 2. Cleaning fluids in hermetically sealed packaging to prevent cross-contamination
 3. High-absorbency optical-grade fabric wipes (not paper)
 4. Acceptable Manufacturers: Sticklers; or approved Alternate

PART 3 - EXECUTION

3.1 GENERAL

- A. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- B. Provide all labor, materials, tools, and test equipment for the testing and measurement of the installed optical fiber cabling.
- C. Coordinate the optical fiber testing with other applicable trades.
- D. Notify the Owner or the Owner's representative of any non-specified tests deemed necessary to guarantee a fully functional system.
- E. Provide system closeout documentation including test measurement results in electronic spreadsheet format and native file format from the test instrument along with viewing software prior to final acceptance.
- F. Provide test measurements carried out in accordance with the Tier 2 specification of TIA-568, plus an image capture of connector end-faces. Include length measurement, attenuation measurement, verifying polarity (using an optical loss test set (OLTS) and obtaining a trace and event table of the fiber with an optical time domain reflectometer (OTDR).

- G. Perform single direction testing with an OLTS.
- H. Perform bi-directional OTDR testing with a launch and tail fiber on each optical fiber cabling link (adapter to adapter) reporting the bi-directional average.
- I. Provide testing documentation for:
 - 1. Single mode links (1310 nm and 1550 nm)
 - 2. OLTS length measurements for singlemode links
 - 3. OTDR traces and event tables for singlemode links
 - 4. Image captures of connector end-faces.
- J. Observe safety precautions in ANSI Z136.2 for testing that use lasers or LED light sources
 - 1. High power light sources should not be directly viewed, use indirect viewing by pointing the end of the fiber at an adjacent surface to determine the presence of light.
- K. Calibrate the field-test instruments as recommended by the manufacturer, or at least within one year of project test measurements. The field-test instrument shall contain the most recent software and firmware provided by the manufacturer prior to testing.
- L. Prior to testing, the labels for all outlets, cables, patch panels and associated components must be in place. Testing performed prior to proper labeling shall be retested.
- M. Visually inspect and clean all fiber connectors immediately prior to testing. Utilize high-quality fiber test reference leads and verify every 288 test cycles. The test reference cord verification result shall be stored and submitted as part of the overall test results submission.
 - 1. Verify the condition of the fiber end faces as well as the test leads *prior* to testing.
 - 2. Provide documentation to prove this step was taken.
- N. Perform testing on each cabling segment in accordance with TIA-568, Tier 2 including:
 - 1. verify polarity
 - 2. measuring length
 - 3. OLTS attenuation measurement
 - 4. OTDR trace analysis
- O. Record an image of each fiber optic connector endface for the closeout documentation.
- P. Submit the optical fiber link test results from the OLTS, and OTDR field-test instruments as part of the closeout documentation.
- Q. Place dust caps on fiber endfaces or adapters on completion of all testing.

3.2 OPTICAL FIBER CLEANING REQUIREMENTS

- A. Utilize wet-dry cleaning methods for removing all forms of contamination and eliminates electrostatic charge.
- B. Use optical-grade cleaning fluids that leave no residue and are fast-evaporating.
- C. Use cleaning fluids in hermetically sealed packaging to prevent cross-contamination. Refillable pump bottles are not acceptable.
- D. Use high-absorbency optical-grade fabric wipes (not paper)
- E. Always clean both ends of a connector pair, and do it just before mating.

- F. Visually inspect and clean new jumpers and patch cords, even if right out of the bag, even if they have protective dust covers on them.
- G. When using stick cleaners, use one stick per end-face to avoid cross contamination.
- H. When using cleaning sticks, only rotate them in one direction: usually four to eight rotations is sufficient.
- I. Mechanical "push-to-clean" cleaners and cassette cleaners are acceptable for light to medium levels of contaminations
- J. Use boxes and tubs of optical -grade wipes plus a cleaning fluid when splicing, regards to pigtails onto bulk cable.
- K. Always clean test assemblies, power meters, light sources and all the other equipment and test gear prior to starting work.

3.3 TESTING PROTOCOL

- A. Provide a testing protocol 1 month prior to testing that will be used in testing of all installed links for review by Owner and consultant prior to implementation.

3.4 OPTICAL FIBER TESTING REQUIREMENTS

- A. OTDR testing
 - 1. Reflective events (connections) shall not exceed 0.40 dB.
 - 2. Non-reflective events (splices) shall not exceed 0.15 dB.
- B. Magnified end face inspection
 - 1. Fiber connections shall be visually inspected for end face quality.
 - 2. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
- C. Perform Automated End Face Grading PRIOR to testing cable plant. Provide test results of this grading.
- D. All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in Part 3. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with Part 3.
- E. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

Note: High Bandwidth applications such as 10GBASE-SR, 40GBASE-SR4, 100GBASE-SR4 and FC1200 impose stringent channel loss limits. Certification shall consider loss length limits that meet maximum channel (transmitter to receiver) loss. Links not in compliance, even though connectivity testing is within loss limits, must be brought to the attention of the Owner or Owner's Representative.

- F. Polarity
 - 1. For duplex connector systems, verify polarity with an OLTS

- G. Length measurement
 - 1. Measure each optical fiber link with the OLTS and OTDR for its length and submit with the closeout documentation

- H. Attenuation measurement (OLTS)
 - 1. General
 - a. Turn on optical light sources for a minimum of 5 minutes prior to referencing.
 - b. Test jumpers shall be reference quality and between 1 m and 5 m in length.
 - c. Reference the light source to the meter a minimum of twice daily
 - d. Fiber test jumpers shall be of the same type, core size and match the performance specifications as the cabling under test
 - e. Clean and allow sufficient time for cleaning solution evaporation, of Fiber test jumpers and fiber links immediately prior to each connection of the test instrument
 - f. Do not remove the test jumper connected to the source after referencing to prevent adverse influence on the attenuation measurement. If the test jumper is disconnected, re-reference to the light source.
 - g. Test singlemode optical fiber at 1310 nm and 1550 nm as referenced in ANSI/TIA-526-7-A, Single Cord Test Reference.
 - h. Measure and report attenuation in one direction for OLTS measurements.
 - i. Measure and report attenuation in both directions for OTDR measurements. (Averaged in both directions)

- I. Optical fiber endface image
 - 1. Capture and record an image of each optical fiber after completing Tier 2 testing of the optical fiber link using either a video fiber scope with at least a 250 μm field of view.

- J. Encircled Flux
 - 1. The launch shall be compliant with ANSI/TIA-526-14-C.
 - 2. VCSEL lasers are not acceptable
 - 3. Utilize testers that can give you an automated pass/fail tests.

- K. OTDR trace analysis
 - 1. Provide an OTDR trace of each optical fiber link in one direction to ensure uniformity of cable attenuation and connector insertion loss
 - 2. Provide and install a launch cable of the same type as the fiber link under test and as specified by the OTDR manufacturer for installation between the OTDR and the first link connection
 - 3. Provide a receive cable, installed after the last link connection as part of the OTDR trace of at least 100 m (328 ft.) in length and of the same fiber type as the link under test.

3.5 IDENTIFICATION

- A. Labeling
 - 1. Labeling shall conform to the requirements specified within ANSI/TIA-606-B or to the requirements specified by the Owner or the Owner's representative.

3.6 ADMINISTRATION

- A. Test results documentation
 - 1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered,

- i.e., "as saved in the field-test instrument". The CSV file format (comma separated value), does not provide adequate protection of these records and shall not be used.
2. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
 3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on a Contractor-Furnished USB memory card prior to Owner acceptance of the building. This USB Memory stick shall include the software tools required to view, inspect, and print any selection of the test reports.
 4. Circuit IDs reported by the test instrument should match the specified label ID (see 3.5 of this Section).
 5. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information
 - a. The identification of the customer site as specified by the end-user
 - b. The name of the test limit selected to execute the stored test results
 - c. The name of the personnel performing the test
 - d. The date and time the test results were saved in the memory of the tester
 - e. The manufacturer, model and serial number of the field-test instrument
 - f. The version of the test software and the version of the test limit database held within the test instrument
 - g. The fiber identification number
 - h. The length for each optical fiber
 - i. Optionally the index of refraction used for length calculation when using a length capable OLTS
 - j. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
 - k. Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
 - l. The length for each optical fiber as calculated by the OTDR.
 - m. The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
 - n. Optional
 - 1) A picture or image of each fiber end-face
 - 2) A pass/fail status of the end-face based upon visual inspection.
 6. Provide summary report of all cables tested in PDF format.
 7. Provide full tester report for each cable tested in PDF format.
 8. Provide the following per CLPCCD standards:
 - a. Native files from test instrument (e.g, .flw if Fluke tester is used)
 - b. Interpreting software (e.g. Linkware)
 - c. Formatted test report in .pdf format
- B. As indicated in 27 00 00, all documentation will be provided in soft and hard bound copies. Hard copies are to be included in an indexed binder with each test or document residing in its own section and listed in the table of contents for easy reference.

END OF SECTION

SECTION 27 0820 - COPPER TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Products and execution requirements relating to testing and documentation for copper cabling for the communication systems, and supplements requirements found in related sections.
- B. Test measurements shall be taken for all balanced-twisted pair cabling, including horizontal and backbone copper cables and wall-to-rack cables. Test all category cables in accordance with current TIA measurement specifications for that category of cabling with a field-test instrument meeting or exceeding Level IIIe accuracy. Provide test measurement results (in electronic format) a minimum of three weeks prior to substantial completion.

1.2 RELATED DOCUMENTS

- A. Related Sections:
 - 1. 270000: Communications
 - 2. 271500: Communications Horizontal Cabling
 - 3. 271600: Communications Connecting Cords Devices & Adapters
- B. The latest versions of the following codes, standards, and guidelines shall be followed. Bring to ITS' immediate attention where construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.
- C. The latest edition of the following standards:
 - 1. ANSI/TIA-568 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - 2. ANSI/TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - 3. TIA TSB-155 - Guidelines for the Assessment and Mitigation of Installed Category 6A Cabling to Support 10GBASE-T
- D. The following guidelines:
 - 1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
 - 2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)

1.3 QUALITY ASSURANCE

- A. All testing procedures and field-test instruments shall comply with applicable requirements of referenced standards.
- B. Test measurements shall be performed by trained technicians who have successfully attended manufacturer training.
- C. The Owner or the Owner's Representative shall be invited to witness, review or both witness and review field-testing.
 - 1. Notify Owner's Representative and Design Engineer of the testing start date, five (5) business days before testing commences.

1.4 SUBMITTALS

- A. The following submittals are due a minimum of three weeks prior to substantial completion, in accordance with the submittal requirements in Section 27 00 00 Communications:
 - 1. Complete test measurement results indicating that all cable permanent links have passed. Submit (2) electronic versions to the Owner's Representative and one for the Design Engineer – Ryan Raskop):
 - a. Microsoft Excel 2010 or later (Manifest)
 - b. Test measurement results in their native format and the manufacturer's PC software to read test results.
 - c. Test shall be organized by media in binders with index and pagination
 - d. Manufacturer factory cable spec sheet and test results for shipped cable.
- B. The following submittals are due Post-Construction, in accordance with the submittal requirements in Section 27 00 00 Communications:
 - 1. On final electronic file submittal (CD/DVD-R or USB Flash Drive), which is to include record drawings, O&M manuals, etc., also include files for all valid test results (as submitted previously).

PART 2 - PRODUCTS

2.1 FIELD-TEST INSTRUMENT

- A. The field-test instrument shall:
 - 1. Be calibrated field-test instruments as recommended by the manufacturer, or at least within one year of project test measurements.
 - 2. Contain the most recent software and firmware provided by the manufacture prior to testing.
 - 3. Be Level IIIe accuracy.
- B. Administration
 - 1. The test measurement result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- C. Approved Products:
 - 1. Fluke DSX-5000 and all associated modules
 - 2. Or Pre-Approved Equivalent: Provide supporting documentation that substantiates claim.

PART 3 - EXECUTION

3.1 GENERAL

- A. All outlets, cables, patch panels and associated components shall be fully assembled, secured/affixed to final mount location, and labeled prior to field-testing. Any test measurements performed on incomplete systems shall be redone on completion of the work.
- B. Tester shall be configured with the manufacturer and model number of cable and connectors, where applicable.

- C. The installed twisted-pair links shall be tested from the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "Permanent Link" performance specification.
- D. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. The test equipment (tester), including the appropriate interface adapter, shall comply with the accuracy requirements for Level IIIe field-test instruments as defined in ANSI/TIA-1152. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 2 of ANSI/TIA-1152 (Table 2 in this TIA document also specifies the accuracy requirements for the Channel configuration).
- E. One hundred percent of the installed cabling links shall pass the requirements of the referenced standards. Diagnosed and correct any failing link.
 - 1. Note and follow with a new test measurement the corrective action to prove that the corrected link meets the performance requirements.
- F. A PASS or FAIL result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field-test instrument manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent '*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.
- G. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any FAIL, FAIL* or PASS* result is considered a FAIL for the link-under-test for this contract. In order to achieve an overall Pass condition, the results for each individual test parameter must yield a rating of PASS. The "*" shall not be turned off on the test instrument.
- H. The records for each cable test measurement shall be provided to the owner a maximum of two weeks after substantial completion in Excel format (manifest) and the native format to the field-test instrument. The Owner can supply an Excel spreadsheet template (manifest) upon request for the contractor's use.

3.2 PERFORMANCE TEST PARAMETERS

- A. Test parameters for category 6A Cables:
 - 1. Wire map
 - 2. Length
 - 3. Propagation delay
 - 4. Delay skew
 - 5. DC Loop Resistance
 - 6. Shield continuity for shielded cables
- B. Test parameters for Category 6A cables (up to 500 MHz):
 - 1. Wire Map
 - 2. Length
 - 3. IL - Insertion Loss
 - 4. NEXT – Near End Cross-Talk
 - 5. PSNEXT - Power Sum Near End Crosstalk
 - 6. ACRF - Attenuation to Crosstalk Ratio – Far End
 - 7. PSACRF - Power Sum Attenuation to Crosstalk Ratio – Far End

8. PSANEXT - Power Sum Alien Near End Crosstalk
9. PSAACRF - Power Sum Alien Attenuation-to-Crosstalk-Ratio from the Far End
10. RL - Return Loss
11. Propagation Delay
12. Delay Skew
13. Shield continuity for shielded cables
14. DC Loop Resistance for balanced and unbalanced signals
 - a. Max 21 ohms

C. Alien Crosstalk sampling

1. Shall be performed for Category 6A cables used for 10Gb/s, and all Category 6A cables in the same bundle as well as adjacent links, using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859-1 for populations of up to 500,000 links shall be used. The following table represents this sampling level:

Total number of links (N)	Sample size (No. of links to test)
3 – 33	3 or 0.1 x N (whichever is greatest)
34 – 3,200	33
3,201 – 35,000	126
35,001 – 150,000	201
150,001 – 500,000	315

D. Test parameters for other cables:

1. Continuity to the remote end;
2. Shorts between any two or more conductors;
3. Crossed pairs;
4. Reversed pairs;
5. Split pairs;
6. Shield continuity for shielded cables, and
7. Any other miss-wiring.

3.3 TESTING PROTOCOL

- A. Provide a testing protocol 1 month prior to testing that will be used in testing of all installed links for review by Owner and consultant prior to implementation.

3.4 ADMINISTRATION

A. Test results documentation

1. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period. The contractor shall retain a copy to aid preparation of as-built information.
2. Circuit IDs reported by the field-test instrument shall match the label ID specified by the Owner.
3. The detailed test results documentation data is to be provided in an electronic database for each tested link and shall contain the following information
 - a. The identification of the customer site as specified by the end-user
 - b. The name of the standard selected to execute the stored test results
 - c. The name of the test personnel
 - d. The date and time the test results were saved in the memory of the tester

- e. The manufacturer, model and serial number of the field-test instrument
 - f. The version of the test software and the version of the test standards database held within the test instrument
 - g. The copper identification number
 - h. The length for each copper cable
 - i. The overall Pass/Fail evaluation of the channel test.
4. Provide summary report of all cables tested in PDF format.
 5. Provide full tester report for each cable tested in PDF format.
 6. Ensure that sweep frequency measure graphs are included in reports.

END OF SECTION

SECTION 27 1100

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes basic communications room requirements, and supplements requirements found in related sections. Refer to "T" series drawings for specific communication room requirements:
- B. Related Sections
 - 1. 061000: Rough Carpentry
 - 2. 270000: Communications
 - 3. 270526: Grounding and Bonding of Communication Systems
 - 4. 270810: Optical Fiber Testing and Measurement
 - 5. 270820: Copper Testing
 - 6. 271300: Communications Backbone Cabling
 - 7. 271500: Communications Horizontal Cabling
 - 8. 271600: Communications Connecting Cords Devices & Adapters

1.2 SCOPE OF WORK

- A. Provide all labor, materials, tools and equipment required for the complete and proper communications equipment room fittings installation.
- B. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the communications equipment room fittings installation with other applicable trades.
- C. In addition to the details specified within this Section, the contractor shall notify the Owner's Representative of any additional items deemed necessary to guarantee a fully functional system. The contractor shall furnish and install all necessary items for a fully functional system at no additional charge.
- D. Furnish and install the following as indicated on the plans:
 - 1. Racks
 - 2. Cabinets
 - 3. Enclosures
 - 4. Cable runway and accessories
 - 5. Cable management panels.
 - 6. Building entrance terminal and protectors.
 - 7. Primary and secondary building entrance protection
 - 8. Patch panels and other connecting hardware as needed
 - 9. Backboards

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of an integrated, welded wire grid of bottom and side rails.

- B. Equipment Room: An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect and security equipment (ER). Sometimes referred to as MDF.
- C. Entrance Facility: A space in a building which the joining of campus to building telecommunications backbone facilities takes place (EF).
- D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- E. Telecommunications Room: An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling and security equipment (TR). Sometimes referred to as an IDF.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- C. Remaining paragraphs are defined in Division 01 Section "Submittal Procedures" as "Informational Submittals."
- D. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.
- E. Qualification Data: For installers, qualified layout technician, installation supervisor, and field inspector.
- F. Seismic Qualification Certificates: For floor-mounted racks and cabinets, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings will be under the direct supervision of a RCDD.
 2. Installation Supervision: Installation will be under the direct supervision of a Registered Technician who will be present at all times when Work of this Section is performed at Project site.
 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.
 4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569, most recent edition of the TIA standard.
- C. Grounding: Comply with TIA-607, most recent edition of the TIA standard.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment frames until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.7 COORDINATION

- A. Electrical Contractor shall furnish and install the following:
1. Power circuits to telecommunications spaces and equipment.
- B. Unless noted otherwise, the following items will be provided by the Owner:
1. All electronics and active data networking equipment, etc.
 2. Telephones, fax machines and modems, etc.
 - a. Contractor shall coordinate location of electrical receptacles to be installed on raceways, racks or inside cabinets.
 - b. Contractor will be responsible for mounting owner-provided equipment in all architectural walls and ceilings as noted on the Project Documents.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND HARDWARE

- A. Provide all termination hardware, horizontal cable management, accessories, doors, etc., for a complete system installation.

2.2 PATHWAYS

- A. General Requirements: Comply with TIA-569.
- B. Cable Support: NRTL listed, Plenum rated.
- C. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
- D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes will be no smaller than 4-11/16 "square and 3 inches deep.

2.3 CABLE RUNWAYS

- A. UL Classified and Listed.
- B. Rung Spacing: 12 inches on center.
- C. Furnish and install all connectors and fittings, as required. Where cables drop out of the cable tray, "drop-out" fittings shall be furnished and installed.
- D. Cable tray shall be approved as a ground conductor or ground conductor clamps shall be furnished and installed for each section with appropriate sized ground wire between sections.
- E. Material: Steel.
- F. Finish: Black powder coat
- G. Provide runway waterfalls for all locations where there is a 2' or greater vertical drop from room entrance to horizontal ladder
- H. Provide runway radius drops on rungs over vertical cable managers and where cable exits the side of the runway.
- I. Approved Products:
 1. CPI Cable Runway, Size as indicated on the drawings
 2. No Approved Equal

Where

xx = inches, sized as indicated on drawings

2.4 BACKBOARDS

- A. The Backboards: A/C grade plywood, void free, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).
- B. Plywood must be kiln dried to a maximum moisture content of 15 percent.
- C. Must be treated on all sides with at least two coats of fire-resistant, painted flat white.
- D. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry".
- E. Mount plywood with fire stamp to room interior. Stamp to be masked during painting and uncovered upon completion.
- F. Provide in close-out submittals Bills Of Lading to prove fire-retardant properties of plywood and paint.
- G. Secure sheets to studs at regular 18" or fewer intervals with screws penetrating into studs a minimum of 3/4".

2.5 CATEGORY 6A PATCH PANELS

- A. Angled Only (Not Flat Panels Allowed)
 - 1. 48 ports (ONLY); 2RU
 - 2. Modular for insertion of jacks to denote color-coded ports
 - 3. Write-on blocks or strip
 - 4. 16-gauge steel with White port numbering on a Black finish
 - 5. Rear lacing bar
 - 6. Category 6A rated

- B. Approved Products:
 - 1. SYSTIMAX 360™ GigaSPEED X10D® 1100GS6 Evolve Angled Category 6A U/UTP Patch Panel, 48 port
 - a. Terminate voice and data circuits on the same patch panels in ascending outlet / jack order

2.6 LC FIBER OPTIC PATCH PANELS/ENCLOSURES

- A. Fiber Termination:
 - 1. Provide LC connectors for fire alarm fiber cabling terminations
 - a. LC connectors are exclusively used for fire alarm systems
 - b. MTP connectors are not allowed under any circumstances
 - 2. Provide SC connectors exclusively for data communications fiber
 - a. 6-strands per connector panel
 - 3. Provide rack-mount termination shelf for data communications backbone cabling
 - a. Provide HD-4U for MDF / BDF locations
 - b. Provide HD-2U for all IDF locations
 - 4. For inside plant, utilize pig tail splicing connectors, and for OSP fiber, utilize fan out kits for termination of the fiber.
 - 5. Adapter plates shall be precision-molded, utilize Zirconia-ceramic ferrules, and color-coded to match fiber type and application.
 - 6. In the B1900A MDF, the fiber will terminate on available slots in an existing 4U patch panel

- B. Approved Products
 - 1. Commscope Systimax HD-2U and HD-4U fiber patch panels, no alternates
 - 2. Provide wall-mount termination panel for fire alarm fiber
 - a. Product: WB2-EMT-BK, no alternates
 - 3. Data fiber (network) terminate fiber on SC connectors (6 strands per connector slot).
 - 4. Fire alarm fiber terminates on LC connectors. (12-strands per connector slot)

2.7 STANDARD RELAY RACKS

- A. All equipment racks and their hardware shall match in appearance and shall be provided by a single manufacturer.
 - 1. Universal hole pattern on the front and rear flanges, and threaded mounting holes on both sides of rack assembly for management
 - 2. Brackets with an eight inch mounting floor plate on the front and rear.
 - 3. Racks will be black in color.
 - 4. Provide 32 spare screws per rack.
 - 5. Horizontal cable support bar on rear of each patch panel/cross connect block panel to support hook and loop (Velcro) strain reliefs. Cables will not rely on terminations for cable support.

6. Hook and loop (Velcro) cable strain relief system on rear of rack to support horizontal and backbone cables. Tie-wraps are specifically prohibited.
7. Hook and loop (Velcro) horizontal and vertical cable management on front of rack for dressing patch cable and cross connect wiring. Tie-wraps are specifically prohibited.
8. Hook and loop (Velcro) cable management system independent of cable management to properly dress the electronic equipment power cords through the rack maintaining as much clearances between the two as possible. Tie-wraps are specifically prohibited.
9. Bonding and grounding cables for all equipment not directly bolted to equipment rack (i.e. shelf mounted electronic equipment, etc.).
10. Surge protected power strip as described in this specification.
11. All hardware, supplementary steel, channel and supports as required properly assembling the rack and supporting it to the building structure.
12. All equipment racks and their hardware will match in appearance and will be provided by a single manufacturer.
 - a. Furnish and install vertical wire management channels on both sides of racks.
 - b. Furnish and install horizontal wire management units, quantity and type as indicated on the drawings.
 - c. Furnish and install ground terminal block/lug for each rack and #6 ground wire to room ground bus bar.

B. Include two each vertical cable managers per standalone rack, or one vertical manager between each rack, and one at each end of a row.

C. Approved Products:

1. CPI Universal 48 RU rack, # 46053-705

2.8 VERTICAL WIRE MANAGERS (VWM)

A. All cable managers and their hardware shall match in appearance and shall be provided by a single manufacturer.

B. Vertical cable managers shall be dual-sided (front and rear), and include doors.

C. Include two each vertical cable managers per standalone rack, or one vertical manager between each rack, and one at each end of a row. Refer to plans for size and location of vertical cable managers.

D. Approved Products:

1. CPI Evolution g2 Double-sided VWM, 12" wide, no alternates

2.9 BRAIDED CABLE SLEEVES

A. Provide braided cable sleeves for cabling in rooms.

B. Polyester expandable sleeving: Flame-retardant and halogen-free.

C. Acceptable Manufacturer:

1. Dell City
2. JDD Tech
3. Approved alternate

2.10 FLOOR PLAN MAPS WITH NUMBERED WORK AREA OUTLETS

- A. Provide a full size plan of floor plan in each telecom room with numbering associated with each work area outlet for that floor or area and mount on TR wall(s).

2.11 PLYWOOD BACKBOARDS

- A. 3/4" grade AC fire retardant plywood required.

2.12 SERVICE LOOPS

- A. Excess cable coiled on wall shall be secured in a cable support ring
- B. Approved products:
 - 1. Leviton Inside Plant Storage Ring, 12", # 48900-IFR
 - 2. Leviton Outside Plant Storage Ring, 24", # 48900-OFR

2.13 ANTI STATIC FLOORS

- A. Flooring may be either tile or epoxy.
- B. Main equipment rooms (data center, server rooms, MPOE, etc.) are to be static dissipative in nature.
- C. Smaller TRs may be anti-static.
- D. Acceptable Manufacturers;
 - 1. Armstrong tile
 - 2. EPF floors
 - 3. Approved alternate

2.14 BUILDING ENTRANCE PROTECTION

- A. For each copper OSP cable that extends beyond the drip line of the building, a single cable entrance protector is required at each end.
 - 1. 100-pair as required by application.
 - 2. Housing and cover constructed of 18 gauge steel, epoxy powder coated.
 - 3. Input terminations shall be 110 type. [Furnish stub length as required. Furnish splice case for stub connected protectors, size as required.]
 - 4. Output terminations shall be 110 type.
- B. Furnish 5 spares per protector.
- C. Approved Products
 - 1. CircaMax 100-pair stub-in protector panel
 - 2. CircaMax protection fuse for data, 300V, with heat coil, v
 - 3. CircaMax protector module for voice, 235V

PART 3 - EXECUTION

3.1 ADDITIONAL INFORMATION

- A. Refer to Section 27 00 00 for the following Part 3 - Execution information

1. General
2. Cable Pathways
3. Work Area Outlets
4. Installation Practices
5. Labeling
6. Firestopping
7. Sealing of Penetrations and Openings
8. Cable Supports
9. Cable Protection
10. Grounding
11. Documentation
12. Training
13. Cleaning
14. Project Closeout

3.2 ENTRANCE FACILITIES

- A. Contact Owner's IT a minimum of one week prior to installation of Entrance Facility hardware and equipment for any instructions they may have for this facility.
- B. Install underground or aerial pathways complying with recommendations in TIA-569, "Entrance Facilities" Article.

3.3 UNDERGROUND ENTRANCE PATHWAY

- A. Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Comply with NECA 1.
- C. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.4 EQUIPMENT RACKS AND CABINETS

- A. Securely mount equipment cabinet and racks to the building structure.
 1. Proper quantities and supports such as 3/8" lag screws and expansion anchors will be used.
 2. Drywall screws and other types of supports not specifically approved to anchor equipment are specifically prohibited. Submit mounting supports for approval before installation.
- B. Equipment cabinet mounted on or against walls will have 3-foot clearance in front of deepest component.
- C. Patch Panels: Mount patch panels into the cabinet/rack in top-to-bottom fashion with the first patch panel (Fiber) mounted at the top of the "Active" equipment rack. Uniquely label each patch panel according to the numbering convention outlined in the SECTION on labeling. Each port will also have color-coded identifiers. Refer to details on the Drawings.
- D. Cable Management: Secure the cable bundle(s) to the rack strain relief and cable management behind the patch panels and cross connect block panels. Install horizontal

cable management panels and brackets for routing and management of patch cables. Maintain TIA and BICSI standards on bundling, supporting and bend radii.

3.5 SERVICE SLACK LOOPS

- A. Service loops are required for all fiber runs so that they can be relocated or spliced, if necessary.
 - 1. Provide a 20-25 foot service loop at each end of an inter-building fiber cable.
 - 2. Fiber cable slack can be coiled and mounted to backboard using specified storage rings, or on underside of ladder if it does not affect other cabling.
 - 3. Provide 15 feet of service loop for riser cabling at both ends.

3.6 CABLE ROUTING FROM LADDER TO RACKS VERTICAL MANAGERS

- A. In the ER/TR, cables shall be combed and dressed with Velcro ties in a manner as to prevent twists, "braiding" or "divers", and crossed cables in the cable bundle from the telecommunication room entrance to the termination point at the rear of the patch panel. Behind the patch panel, the cable bundle shall be attached to the rear cable support bar, and each cable shall drop out of the bundle in a neat, cascading manner to prevent crossed and/or interwoven cables to each patch panel port termination point.
- B. Neatly dress and manage cable transitions from the ladder with hook-and-loop fasteners.
 - 1. Max Loading Depth:
 - a. 3 inch bundles attached to cable runway.
 - b. Furnish and install vertical cable retaining posts on both sides of all cable drop outs, and along ladders where loading depths exceed 2 inches.
 - c. Confirm appropriate ladder sizing with owner representative for horizontal cabling, backbone cabling, and any rack-to-rack cabling installed by owner, prior to ordering and installing ladder.
 - 1) Increase ladder width if filled with greater than 3" deep cable bundles.
 - 2) Route cable bundles off the ladder such that cables on the 'bottom' are not crushed or kinked regardless of bundle sizes.
 - a) Utilize hook-and-loop fasteners on bundles *and* vertical posts to manage the horizontal to vertical transition regardless of bundle sizes if required to maintain cable integrity (no kinks or crushed cables).
 - b) Black wire "socks" or sleeves are also permitted for cable bundles
- C. Where the distance of cabling entering the room to horizontal cable runway exceeds 18", provide cable support in the form of vertical cable runway that is affixed to wall and to horizontal runway. Where space permits, install cable runway bend radius to effect this transition. Affix cable bundles to runway with hook & loop fasteners.

3.7 BONDING AND GROUNDING

- A. Refer to Section 27 05 26 for Bonding & Grounding requirements.
- B. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Protection".
- C. Comply with TIA-607.
- D. Locate grounding bus bar to minimize the length of bonding conductors.
- E. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar.

- F. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- G. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
- H. Retain subparagraph below if screened twisted-pair cables and coaxial cables are in communications equipment rooms.
 - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.8 ANTI STATIC AND STATIC DISSIPATIVE FLOORING

- A. Refer to architectural documents for other information
- B. Provide copper bonding conductor for the dissipative flooring that is bonded to telecommunications grounding system.

3.9 BRAIDED CABLE SLEEVES

- A. Provide expandable braided cable sleeves for routing cable bundles from point of entry to racks and cabinets.
- B. Clarify with Owner if color coding of sleeving is required for different device types.

3.10 SEISMIC CONSIDERATIONS

- A. Contractor is responsible to install a fully functional UL Listed system, which when complete, shall be rated for the Seismic Design Category (SDC) in which it is installed, based on the *current* IBC. Coordinate with the architect and structural to verify or determine this parameter
- B. Install all bracing, straps, bolts, etc. to meet this requirement regardless of T series drawings depictions.
- C. Installations or field modifications to installation designs shall be coordinated with a structural engineer.
 - 1. Provide shop drawings that conform to structural engineer's approved attachment and loading requirements.
 - 2. With respect modifications required due to field conditions, coordinate with and receive approval from a licensed structural engineer.
 - 3. Submit for inclusion in the Project Manual structural engineer's approved methods and attachment and loading requirements.

3.11 BACKING

- A. Plywood must be securely fastened to wall framing members to ensure that it can support attached equipment.
 - 1. Affix plywood to all studs a minimum of every 18" with screws that penetrate a minimum of 1" into studs.
 - 2. Screws must be flush with plywood. Countersink if required to meet this requirement.
 - 3. Wall linings will extend from 1' AFF to 9' AFF, with cutouts at electrical outlet locations.
 - 4. These cutouts shall be no larger than the electrical outlet itself.
 - 5. Paint plywood backboards a light color.

6. Cover fire rating stamps before painting so they are clearly visible when painting is complete.
 - B. Proceed with caution so paint does not get on any of the cabling. Any cabling that is painted will need to be completely replaced at the contractor's expense.
 - C. Flush hardware and supports must be used to mount the plywood.
 - D. Install with the A grade surface exposed.
 1. Coordinate with Owner and fire marshal to determine if fire rating must be exposed, or if bill of lading can be presented to validate fire rating of plywood. If this is allowed, place smooth side of plywood to room interior.

END OF SECTION

SECTION 27 1300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section governs the products and execution requirements relating to furnishing and installing backbone cabling for the communication systems, and supplements requirements found in related sections.
- B. Related Sections:
 - 1. 270000: Communications
 - 2. 270526: Grounding and Bonding of Communication Systems
 - 3. 270810: Optical Fiber Testing and Measurement
 - 4. 270820: Copper Testing
 - 5. 271100: Communications Equipment Room Fittings
 - 6. 271500: Communications Horizontal Cabling
 - 7. 271600: Communications Connecting Cords Devices & Adapters

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- A. All conduit and EMT required for Communications cabling pathway in/out of cross connect closets and in/out of wall cavities at the work area. EMT or Conduit for pathways shall have no more than two 90-degree bends and no continuous section over 100'.

1.3 WORK INCLUDED

- A. The Work of this Section shall consist of the labor, materials and equipment required for installing and/or furnishing backbone cabling as part of a complete and operating telecommunications cabling system.
- B. All items specified or included in this section shall be furnished and installed by Telecommunications Contractor, wired and connected by Telecommunications Contractor and tested by Telecommunications Contractor, unless noted otherwise. "Contractor" as used herein shall mean Telecommunications Contractor or Telecommunications Contractor's sub-contractor.

1.4 SUBMITTALS

- A. Submit for approval in accordance with specified submittal procedures.
- B. Prepare submittals for all components of the telecommunications system, as specified herein.

1.5 COORDINATION

- A. Contractor shall furnish and install as required:
 - 1. Inside plant copper backbone cables.
 - 2. Inside plant fiber optic backbone cables.
 - 3. Outside plant copper backbone cables
 - 4. Outside plant fiber optic backbone cables
- B. Electrical Contractor shall furnish and install the following:
 - 1. Telecommunications raceways within the building.
 - 2. Telecommunications duct banks, hand-holes and manholes.

PART 2 - PRODUCTS

2.1 FIBER OPTIC CABLES

- A. Cable may be either of composite cable construction or standard cable containing single-mode fibers in one cable sheath and multi-mode fibers in a separate cable sheath. Contractor shall verify raceway fill requirements when furnishing and installing two standard cable constructions to meet composite strand count requirements.
- B. Fiber Optic Cable Shipping Requirements
1. All cabled optical fibers > 1000 meters in length shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.
 2. Top and bottom ends of the cable shall be available for testing on the shipping reel.
 3. Both ends of the cable shall be sealed to prevent the ingress of moisture.
 4. Each reel shall have a weather resistant reel tag attached identifying the reel and cable. The reel tag shall include the following information:
 - a. Cable Number, Gross Weight
 - b. Shipped Cable Length in Meters, Job Order Number
 - c. Manufacturer Product Number, Customer Order Number
 - d. Date Cable was Tested, Manufacturer Order Number
 - e. Cable Length Markings, Item Number
 - 1) Top (inside end of cable)
 - 2) Bottom (outside end of cable)
- C. Each cable shall be accompanied by a cable data sheet. The cable data sheet shall include the following information:
1. Manufacturer Cable Number, Manufacturer Product Number
 2. Manufacturer Factory Order Number, Customer Name
 3. Customer Purchase Order Number
 4. Mark for Information Ordered Length
 5. Maximum Billable Length, Actual Shipped Length
 6. Measured Attenuation of Each Fiber Bandwidth Specification (for lengths > 1000 m)
- D. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.
- E. Acceptable Manufacturer: Commscope Teraspeed, no alternates
1. Cable may be either of composite cable construction or standard cable containing single-mode fibers in one cable sheath and multi-mode fibers in a separate cable sheath. Contractor shall verify raceway fill requirements when furnishing and installing two s
 2. Standard cable constructions to meet composite strand count requirements.
 3. Fiber Cable - Outside Plant
 - a. Cable Construction:
 - 1) Loose tube, up to 12 fibers per tube.
 - 2) Dry water-blocking tape.
 - 3) Fillers as required by strand count and cable construction.
 - 4) Epoxy glass central strength member.
 - 5) Reverse oscillation stranded buffer tubes.
 - b. Jacket Material: Medium density polyethylene
 - c. Fiber Count: As indicated on Drawings.
 - d. Fiber Type:
 - 1) Single-mode: 8.2/125.
 - e. Color coded 250-micron coated fibers.
 - f. Color code: TIA/EIA-598-A, Optical Fiber Cable Color Coding.
 - g. Jacket Color: Black

- h. Maximum Pulling Tension: 2700 N (600 lb/f) during installation, 890 N (200 lb/f) installed
 - i. Storage Temperature: -40 to +70 degrees C (-40 to +158 degrees F).
 - j. Installation Temperature: -30 to +60 degrees C (-22 to +140 degrees F).
 - k. Operating Temperature: -40 to +70 degrees C (-40 to +158 degrees F).
- 4. Fiber Cable – Inside Plant, Riser
 - a. Cable Construction:
 - 1) Distribution type.
 - 2) Individually jacketed bundles for strand counts greater than 24.
 - 3) Central Strength Member:
 - a) Up to 24 strand: Aramid yarn.
 - b) Greater than 24-strand: Flexible glass/epoxy rod.
 - b. Jacket Material: Fire retardant PVC, OFNR rated.
 - c. Fiber Count: As indicated on Drawings.
 - d. Fiber Type:
 - 1) Single-mode: 8.2/125.
 - e. 900 micron tight buffered fibers.
 - f. Color Code: TIA/EIA-598-A, Optical Fiber Cable Color Coding.
 - g. Jacket Color: Yellow
 - h. Maximum Pulling Tension:
 - 1) Up to 12 strand: 660 N (148 lb/f) during installation, 198 N (45 lb/f) installed.
 - 2) 18 strand and above: 1320 N (297 lb/f) during installation, 396 N (89 lb/f) installed.
 - i. Storage Temperature: -40 to +70 degrees C (-40 to +158 degrees F).
 - j. Installation Temperature: -10 to +60 degrees C (+14 to +140 degrees F).
 - k. Operating Temperature: -20 to +70 degrees C (-4 to +158 degrees F).
- 5. Optical Fiber Performance Requirements (OSP and ISP fiber cables) Glass Transmission Media - Single Mode
 - a. Acceptable Manufacturer: CommScope TERASPEED OS2, no alternates
 - b. Dispersion unshifted, low water peak.
 - c. Proof tested to 100 kpsi
 - d. Cable cutoff wave length <1260 nm.
 - e. Glass Geometry:
 - 1) Fibercurl: > 4.0mm radius of curvature.
 - 2) Cladding Diameter: 125.0 ± 0.7 µm
 - 3) Core: Clad Concentricity: - < 0.50 µm
 - 4) Cladding Non Circularity: < 1.0%.
 - f. Cabled Fiber Optical Performance:
 - 1) 1310 nm: - < 0.4 dB/Km, maximum
 - 2) 1383 nm: ± 3 nm ≤ 22 dB/Km
 - 3) 1550 nm: < 0.20 dB/Km, maximum
 - 4) Zero Dispersion Wave Length: 1302 ≤ wavelength ≤ 1322
 - 5) Zero Dispersion Slope: 0.086 psi/(nm.km)
 - 6) Refractive Index Difference: 0.36%
 - 7) Numerical Aperture: 0.14
 - 8) In compliance with TIA/EIA 492-CAAB and Telecordia's GR-20.
 - 9) Enhanced water peak at 1383 nm.
- 6. Fiber Optic Cable Shipping Requirements
 - a. All cabled optical fibers > 1000 meters in length shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.
 - b. Top and bottom ends of the cable shall be available for testing on the shipping reel.
 - c. Both ends of the cable shall be sealed to prevent the ingress of moisture.
 - d. Each reel shall have a weather resistant reel tag attached identifying the reel and cable. The reel tag shall include the following information:
 - 1) Cable Number, Gross Weight
 - 2) Shipped Cable Length in Meters, Job Order Number

- 3) Manufacturer Product Number, Customer Order Number
- 4) Date Cable was Tested, Manufacturer Order Number
- 5) Cable Length Markings, Item Number
 - a) Top (inside end of cable)
 - b) Bottom (outside end of cable)
- e. Each cable shall be accompanied by a cable data sheet. The cable data sheet shall include the following information:
 - 1) Manufacturer Cable Number, Manufacturer Product Number
 - 2) Manufacturer Factory Order Number, Customer Name
 - 3) Customer Purchase Order Number
 - 4) Mark for Information Ordered Length
 - 5) Maximum Billable Length, Actual Shipped Length
 - 6) Measured Attenuation of Each Fiber Bandwidth Specification (for lengths > 1000 m)
- f. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

2.2 FIRE ALARM OPTICAL FIBER MULTIMODE CABLE

A. Manufacturers:

1. CommScope
2. No Alternates

B. Fiber Type:

1. Multimode, graded-index
2. Core/Cladding Diameter: 62.5/125 μm
3. Classification: OM1
4. Strand Count: 12-fiber
5. Construction: Tight-buffered, distribution-style or breakout-style depending on application
6. Jacket Rating:
 - a. Riser-rated (OFNR) or
 - b. Plenum-rated (OFNP) as required by site conditions and code compliance

C. Optical Performance Requirements:

1. Wavelengths:
 - a. 850 nm
 - b. 1300 nm
2. Attenuation (maximum):
 - a. 3.5 dB/km @ 850 nm
 - b. 1.0 dB/km @ 1300 nm
3. Bandwidth:
 - a. 200 MHz·km @ 850 nm
 - b. 500 MHz·km @ 1300 nm

D. Mechanical Performance:

1. Minimum bend radius (installation): per manufacturer's recommendation
2. Tensile strength (installation): 600 N (typical)
3. Crush resistance: 220 N/cm (minimum)

Markings and Identification:

1. Cable jacket shall be red and labeled "FIRE ALARM – FIBER OPTIC CABLE" at intervals not exceeding 3 feet.
2. Include sequential length marking.
3. Jacket shall be clearly labeled with manufacturer name, part number, fiber type, and UL listing.

E. Compliance and Standards:

1. ANSI/TIA-568.3-D
2. ANSI/TIA-598-D (color coding)
3. NFPA 70 (NEC), Article 770
4. NFPA 72 (National Fire Alarm and Signaling Code)
5. UL 1651 (for optical fiber cables)
6. Local AHJ requirements

2.3 COPPER OSP CABLE (BACKBONE CABLE)

- A. Cables should be specifically PE89, gel filled, qualpeth sheathed with aluminum shield, 22 AWG, multi-pair cables.
- B. See one line diagram in the drawings for required pair counts.
- C. Minimum performance specifications: The cables shall meet the requirements of ANSI/EIA/TIA-568B for 100- Ohm UTP Multi-pair Backbone Cable.
- D. Non-hygroscopic core wrap.
- E. The insulation of the tip conductor shall be marked with a stripe of the mating ring insulation color.
- F. Manufacturer/Product: Superior Essex Sealpic-FSF RDUP PE.89 Part#: 09-069-02-xx (xx = pair count)
- G. Multi-pair Cable - Inside Plant Riser, Category 3
 1. Acceptable Manufacturer:
 - a. Systemax,/Commscope
 - b. Approved equal.
 2. Cable type: Category 3 – CMR – Polyolefin or CMP – Low smoke fire retardant FEP.
 3. Jacket Markings: Manufacturer's identification, pair count, wire AWG, sequential footage.
 4. Conductors: Solid 24 AWG copper
 5. Twisted pairs with varying lay lengths, quantity of pairs as indicated on Drawings.
 6. Conductor Insulation:
 7. Industry standard color coding, with colored binder tape for cable sizes greater than 25-pair.
 8. Jacket Color: Grey
 9. Electrical Characteristics: Meets TIA/EIA-568B requirements for Category 3 rated cables.
 10. CMR rated cable for installation in vertical risers and conduit
 11. CMP rated cable for installation in plenum air spaces

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General

1. All cable and associated hardware shall be placed so as to make efficient use of available space in coordination with other uses. All cable and associated hardware shall be placed so as to not impair the use or capacity of other building systems, equipment, or hardware placed by others (or existing).
2. Where cable is placed in ceiling areas or other non-exposed areas, cables shall be installed in cable trays or in non-continuous cable support system. Non-continuous cable supports shall be placed at random intervals no greater than 48 inches. Cables in non-continuous support systems shall be bundled using hook and loop type fasteners. Cable sag between supports shall not exceed 3 inches. Attaching wire to pipes or other mechanical items is not permitted. Cables shall not be bundled or tied in conduits, and in cable trays above ceilings.
3. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purposes such as access boxes, network equipment, mechanical equipment access doors and covers, switches or electrical panels, and lighting fixtures. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser at a later time by maintaining a working distance from these openings. All cable shall be installed to allow for simple installation and removal of cables in the future.
4. Unless noted, all interior wiring shall be installed in raceways. Wiring above accessible ceilings may be installed in cable tray and exposed on "J" hooks.
5. All cables not in raceways shall be riser or plenum rated.
6. All cables running outside the building shall be rated for outside plant installation.
7. Backbone cables shall be grouped separately from horizontal distribution cables. Cable for other systems shall be grouped separately from cables for telephone and data.
8. All inside cable shall be installed neatly above accessible ceilings using cable tray and "J" hooks supported from building structure. Do not attach to pipes, conduits, ducts, etc. Do not allow cable to rest on pipes, conduits, ducts, ceiling tiles, etc. Do not attach to wires used for supporting suspended ceilings. Do not use tie wires or bridle rings.
9. All wires shall be marked at all junction boxes, pull boxes, cabinets, boxes and terminations. Each cable run between terminating locations shall be one continuous cable (no splices or connections).
10. The Contractor shall install cable in such a manner as to prevent stretching, kinking or sharp bends. Cable damaged during installation or not passing required testing shall be removed and replaced at no additional cost to Owner.
11. The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over tightened bindings, loosely twisted and over twisted pairs at terminations, and too much jacket removed.
12. Minimum bend radius and maximum pulling tension for all cables shall be maintained during and after installation. Install cable in accordance with manufacturer's ratings and instructions.
13. Cables shall not be installed near power sources or other items where interference could develop. Cables shall not be placed within 18 inches of light fixtures and within 3 feet of motors, transformers, copy machines, or solid state motor starters unless cable is installed in conduit. Contractor shall furnish and install a grounding conduit system where these minimum clearances cannot be maintained.
14. In telecommunications spaces, cables shall be routed as close as possible to the ceiling, floor, or corners to ensure that adequate wall or backboard space is available for current and future equipment and for cable terminations. Cables shall not be tie-wrapped to existing electrical conduit or other equipment. Minimum bend radius shall be observed.
15. Dress and attach cables to the backboard along the shortest possible route run square (horizontal and vertical) to the backboard. Bundle similarly routed cables together and attach by means of clamps or distribution rings. Cable dress and attachment shall minimize obstruction to future installations of equipment, backboard, or other cables.
16. Cables shall be neatly bundled with hook and loop type fasteners. Nylon tie wraps are not acceptable. Cables must be neatly bundled in the telecommunications spaces and at the cable service loop.

17. A break-away link shall be used for installation of cables with a cable-puller or winch. The break-away link shall be designed to separate at or below the recommended maximum tension of the cable being installed.
18. Any damage to Owner's existing cabling or existing cable owned by others, caused as a result of work performed under this scope, shall be brought to the Owner's attention and repaired or replaced within 48 hours.
19. Contractor shall use only cable lubricants recommended by the manufacturer for use with the specific cable construction.
20. Should a cable become kinked, skinned or stretched during installation, the cable shall be removed and replaced at no additional cost to the Owner. Splicing at points other than those specified will not be acceptable.

B. Outside Plant Cable

- a. Extend cabling as required to ultimately terminate in cabinets via tie cables from the wall.

3.2 CONDUITS AND CABLING

- A. Coordinate with electrical contractor to provide conduit pathways for cabling that would otherwise be 'buried' in walls or above ceilings.
- B. All cabling must be permanently accessible, either directly, or via conduits.

END OF SECTION 27 13 00

SECTION 27 1500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes information on horizontal communications cabling supplementing requirements found in the related sections.
- B. Related Sections
 - 1. 270000: Communications
 - 2. 270820: Copper Testing
 - 3. 271300: Communications Backbone Cabling
 - 4. 271600: Communications Connecting Cords Devices & Adapters

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- A. Conduit and EMT required for Communications cabling pathway in/out of cross connect closets and in/out of wall cavities at the work area where ceiling is inaccessible.
- B. Rings (and strings) with conduit connecting tabs for the mounting of NEMA rated faceplates where required.
- C. Drag line or pull string at the ring fished through EMT or conduit to the other end for installing 4 pair and multi-pair cables.

1.3 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all the required material whether specifically addressed in the Specification or not.

1.4 SYSTEMS DESCRIPTION

- A. Horizontal copper cabling system consists of rated cables with four unshielded twisted pairs of solid annealed copper wrapped in plenum rated insulation with an overall plenum rated jacket with a wire thickness of 23 AWG. Each four-pair cable is terminated onto 8 position 8-conductor rated connectors using 110 style IDCs. Connectors are placed into NEMA rated faceplates at the work area and placed into rack mounted patching panels in the equipment / networking rooms.
- B. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - 1. TIA-568 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 - 2. Horizontal cabling will contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - 3. Bridged taps and splices will not be installed in the horizontal cabling.
 - a. A work area includes the components that extend from the telecommunications outlet/connectors to the station equipment.

- b. The maximum allowable horizontal cable length is 250 feet. This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 18 feet in the horizontal cross-connect.

1.5 MANUFACTURER QUALIFICATIONS

- A. Manufacturer shall be a telecommunications product manufacturer with at least 20 years of experience.
- B. Manufacturer shall be ISO 9001 certified manufacturer and shall employ Six Sigma methodology in its manufacturing process.
- C. Where a specific manufacturer is called out by name, this is the preferred standard. If substitutions are allowed, they are at the discretion of the Owner and based on performance, suitability, quality, administrative requirements, warranty and other factors deemed important to the Owner.

1.6 TESTING AGENCY QUALIFICATIONS

- A. Independent testing agencies shall be nationally recognized as having the expertise to independently verify copper and optical fiber cabling systems and components.
- B. Testing Agency Qualifications: Must be a NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Telecommunications Pathways and Spaces: Comply with TIA-569.
- E. Grounding: Comply with TIA-607.

1.7 WARRANTY

- A. Contractor shall provide a 1 year parts and labor warranty against defective workmanship and/or system component failure in addition to the CommScope SYSTIMAX complete cabling system warranty.
- B. Contractor shall execute a Limited Lifetime Product & Performance Warranty covering all components, equipment and workmanship which shall be provided to the Owner, submitted in writing with system documentation. The warranty period shall begin on the system's first use by the owner.
- C. Horizontal channels shall be completed with end to end solutions, with the Commscope Systimax Solution. No alternative solutions are acceptable on the project. Factory-terminated copper and/or fiber optic patch cords from the solutions provider must be used in order to be eligible for the applicable channel performance guarantees.
- D. As further described below, the "Supplier" shall warrant to the customer ("Buyer") that certified network installations will exceed the defined TIA-568 series industry specifications in force at the time of product purchase. Furthermore, the products that comprise the certified Cabling

System will meet or exceed the applicable product performance specifications in effect at the time of manufacture.

- E. This warranty covers the copper and fiber optic permanent links of the network as defined by TIA-568 which includes the cable and connecting hardware. This warranty will be extended to include the entire channel provided that the applicable patch cords and equipment cords are utilized, and all products are installed within areas protected from outside elements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The Electrical Code referred to in these specifications is the National Electrical Code as currently adopted by the State of California. All work will be provided in strict compliance with the Electrical Code and all regulations that may apply.
- B. Where standards exist, for a particular category, products used on this project will be listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL) and be approved or listed for the intended service and application.
- C. These specifications do not undertake to repeat the requirements of codes, regulations or NRTL listing or labeling instructions. The Specifications or Drawings may require items or work beyond the requirements of applicable codes or regulations. The stricter, higher quality, greater quantity or higher cost will be provided. It is incumbent on the Installer, material and equipment suppliers to meet these specifications, applicable codes, regulations, and NRTL listing agency restrictions.

2.2 MANUFACTURER

- A. The word "Manufacturer" will include the Manufacturer, the Manufacturer's Representative, the Distributor, the Fabricator, and the Supplier of the particular classification of equipment, system, product, and material.
- B. All work, equipment, and systems will be manufactured, provided, repaired, installed, and tested in accordance with the latest edition and all current amendments of the applicable publications and standards of the organizations listed below as of the date of the Contract Documents. When the Specification requirements exceed the requirements of these publications and standards the Specifications will govern:
 1. State Building Code (SBC)
 2. Building Department Inspectional Services
 3. American Society for Testing and Materials (ASTM)
 4. Underwriter's Laboratories, Inc. (UL)
 5. Insulated Cable Engineers Association (ICEA)
 6. National Electrical Manufacturers Association (NEMA)
 7. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 8. American National Standards Institute, Inc. (ANSI)
 9. National Fire Protection Association (NFPA)
 10. Local Electric Code
 11. Department of Public Safety (DPS)
 12. Building Officials and Code Administrators International, Inc. (BOCA)
 13. Department of Labor USA. Safety and Health Regulations for Construction (OSHA)
 14. Energy Codes
 15. National Electrical Contractors Association (NECA)

16. National Bureau of Standards (NBS)
17. Federal Communications Commission (FCC)
18. Utilities Serving Project.
19. Fire Department.
20. Americans with Disabilities Act Applications Guidelines (ADAAG).
21. Accessibility Guidelines for Buildings and Facilities.
22. Any and all Federal, State and Local Standards, Codes and Authorities having Jurisdiction.
23. In addition, all phases of the Structured Cabling System installation will adhere to applicable Local Area Network (LAN) Specifications of the Institute of Electrical and Electronics Engineers (IEEE), Electronics Industry Association/Telecommunications Industry Association (TIA/EIA), American National Standards Institute (ANSI), and Building Industry Consulting Service International (BICSI). The entire system and all components will be NRTL certified to appropriate TIA/EIA performance rating Category, Latest TIA Standards 455, 492.CAAAB, 492.AAAC, 492.AAAD, 568, and (SP-4195-B and SP-4195-B-1), 569, 570, 606, 607 and 758 (latest revisions), TIA/EIA TSB 67, TSB 72, TSB 75, TSB 95 and other standards as applicable.

- C. The Installer will have available at the job site at all times one copy of the latest edition of the Electrical Code, TIA and BICSI Standards applicable to the work as specified within this document.
- D. The above requirements will not in any way limit responsibility or requirements to comply with all other codes, standards and laws.
- E. Material, equipment, enclosures, and systems will be designed for use as required to suit the conditions, exterior or interior operation, dust tight, water tight, explosion-proof, or other special types.

2.3 APPROVED PRODUCTS

- A. Approved Connectivity Manufacturer Basis of Design
 1. CommScope Systimax Category 6A UTP cabling solution, 2091B
 - a. No Alternates

2.4 UTP PIN/PAIR TERMINATION ASSIGNMENT

- A. The UTP cabling systems will have TIA/EIA T568B pin/pair termination assignment. All conductors provided will be properly and consistently terminated at both ends throughout the entire systems. Maintain proper untwist of pairs and removal of jacket per TIA and BICSI.

2.5 SYSTEM PERFORMANCE

- A. Horizontal four pair Category 6A copper cabling system shall be capable of supporting 10G Base-T applications for a total distance of 100 meters with equipment cords.
- B. System shall provide "future proof" channel performance and guaranteed margins as noted in this document and is guaranteed to exceed TIA-568 Category specifications for Insertion Loss, NEXT, PSNEXT, ACR, PSACR, ELFEXT, PSELFEXT and Return Losses to 500 MHz for Category 6A. The system is also guaranteed 10 dB PSACR headroom for 6A cabling.

2.6 SYSTEM PERFORMANCE

- A. CAT6A Unshielded (U/UTP, or UTP) Systems

1. Horizontal UTP Category 6A 23AWG copper cabling system shall be guaranteed to exceed all TIA-568 link and channel performance requirements and be capable of supporting 10G Base-T (802.3an) and ISO/IEC 11801 Class EA applications for a total distance of 100 meters with equipment cords. System is guaranteed to meet all Cat 6A requirements for short links and channels down to a 10-foot link (5 meter channel) with a guaranteed 4 dB margin of Alien Crosstalk. Field testing is not required for Alien Crosstalk clearance.
2. Basis of Design is Commscope Systimax Category 6A UTP Cabling Solution
3. CAT6A Performance Parameters, headroom over TIA-568 standard:

Insertion Loss	NEXT	PSNEXT	ACR-F (ELFEXT)	PSACR-F (PSELFEXT)	Return Loss	ACR-N	PSACR-N	PSANEXT	PSAACR-F
3%	5 dB	6 dB	10 dB	10 dB	4 dB	7 dB	7 dB	5 dB	11 dB

2.7 SOURCE QUALITY CONTROL

- A. All materials shall be purchased from Distributors authorized by system Manufacturers to sell new and unused components.

2.8 CATEGORY JACKS

- A. Provide CAT6A rated jacks, cables and patch cord where noted on the design documents.
- B. Communications Faceplate ports shall contain Category jacks which are matched to cable. Jacks shall be terminated to the Horizontal Cabling and inserted into the Communications Faceplate.
- C. Connection Reliability
 1. Use connectors with 50 micro-inches of gold-plated tines (as specified by TIA standards), as well as designs that offset or increase the distance between the connection point of the connector tines and the plug contact point during removal, preventing arc damage.
 2. Connectors should also meet contact resistance requirements found in the IEC 60512-99-001 standard covering connectors for electronic equipment.
- D. CATEGORY 6A JACKS
 1. Provide modular type Category 6A information outlets for 23-AWG copper cable. These Category 6A (CAT6A) connectors shall be individual snap-in style and exceed compliance with TIA/EIA-568-C.2 specifications.
 - a. The jacks shall be CommScope SYSTIMAX MGS600 jacks, No Alternates
 - b. The Jacks shall be white in color for voice circuits and blue in color for data circuits

2.9 UTP CABLE

A. NETWORK DATA CABLES

1. Provide 4-pair, 100-Ohm balanced unshielded twisted pair (UTP) Plenum-rated (CMP) Cables for each data outlet designated.
2. Cable jacketing:
 - a. Shall be Blue for DATA.
 - b. Shall be White for Voice circuits.

3. Cable shall be independently verified for flammability by UL and listed under file number E138034 and shall comply with NEC article 800, NFPA 70, and CMP (NFPA 262, UL 910).
 4. Copper clad aluminum cables are not permitted. Installation of such will be cause for the necessity of removing the cabling and the installation of copper cables at the contractor's expense.
 - a. Any costs associated with project delays caused by the installation of these cables and the removal and installation of acceptable cables will be borne by the contractor.
 5. Terminate all outdoor cables or transition to plenum rated indoor cabling within 50 feet of conduit termination in building.
- B. CAT6A UTP cable shall conform to the following requirements:
1. CAT6A Unshielded twisted-pair cable (U/UTP, or UTP)
 2. 100-Ohm, 23 AWG, CAT 6A 4-pair balanced unshielded twisted pair solid annealed copper
 3. Cable shall be characterized to 750 MHz and UL/ETL Listed by the Manufacturer printed on the cable jacket and package, as well as ETL Verified to TIA-568 Category 6A and ISO/IEC 11801 Class E_A requirements for channel, link and component performance to support IEEE 10GBASE-T (802.3an) networks
 4. Maximum CMP Cable Outer Diameter: 0.275".
 5. Documentation available from an independent third-party testing agency that verifies through random sampling that cable components perform at or above the levels contained on their product specifications, not simply at or above the standard.
 6. Guaranteed cable balance improves overall performance and reduces emissions which results in error-free performance up to 10 Gigabit Ethernet with full duplex transmission
 7. Provided on spools to reduce risk of kinking cable upon deployment
 - ~~8.~~ Cable shall be Plenum-rated CMP
 9. Be made by an ISO 9001 and 14001 Certified Manufacturer.
 10. Meet or exceed Channel margin guarantees as stated above under System Performance
 11. Approved Products:
 - a. Commscope Systimax GigaSPEED

2.10 OUTLET MOUNTING

- A. WALLPLATES
1. Wall plates (or "faceplates") provide information outlets to the work area. Contractor shall provide and install single gang faceplate kits to allow up to four data or voice jacks as required for all work area outlets, workstation base feeds, and unused telecom backboxes and furniture openings (a maximum of four outlets are allowed in any installed faceplate in the project). Faceplates shall:
 - a. Utilize a Quickport footprint to match the approved connectivity manufacturer, and be made by the same manufacturer as the connectors.
 - b. Match colors and materials of the power wiring device plates.
 - c. Support any connectivity media type, including fiber and copper applications.
 - d. Have write-on designation labels for circuit identification together with a clear plastic cover.
 - e. Be available in single-gang and double-gang configurations.
 - f. Have surface-mount boxes and standoff rings available for both single and double gang faceplates.
 - g. Have single-port matching color blank inserts available in packs of 10.
 - h. Approved Products:
 - 1) CommScope M14L plates

Where:

= number of ports: 1, 2, 3, 4. Wall plates beyond quantity of four are not permitted.

x = color: White (W), Ivory (I), Light Almond (T), Gray (G), Black (E)

B. SURFACE-MOUNT BLOCKS (SMB)

1. Surface-Mount Blocks (SMBs) are used to protect terminated CAT6A cables at the endpoints where they are not contained within walls or furniture. Example locations may be Wireless Access Points (WAPs), Group Work Areas fed by conduits run down columns, security cameras, or other network-enabled device locations.
2. Ceiling, WAP, Camera and other non-wall-mount locations will use a 2-port plastic SMB.
3. Small Surface-Mount Boxes shall exhibit the following characteristics:
4. Outlet housings for WAPs and other devices shall be a high-density, low profile design with (2) or (4) field-configurable ports, snap-lock cover, and cable knockouts on back.
5. Housing cover shall have raceway knockouts for top and bottom entry. Base shall include Tie-wrap anchor points at all cable entrances.
6. The housing shall be mountable with screws, tape or a single magnet.
7. The cover shall provide the option of securing it to the base with a screw that is hidden under the outlet identification window.
8. Shall be constructed of a Plenum-rated, high-impact self-extinguishing plastic rated UL 94V-0, and be UL Listed and compliant with FCC Part 68 and TIA-568 specifications.
9. Approved Products:
 - a. Commscope Systemax
 - b. No Alternates

2.11 CABLE SUPPORTS

A. J-HOOKS

1. Support all cable above ceiling on dedicated cable support hardware a minimum of 6" above accessible ceilings. 50 cables maximum are allowed on a single run of J-Hooks. Provide addition J-Hook runs for cable quantities exceeding 50.
2. Provide cable saddles and J-hooks where cable tray or wire basket is not available. These must be supported on their own ceiling wires, threaded rod, or affixed to building structure by use of beam clamps (on metal beams) or wood screws (on wood beams). Affixing communication cable supports to existing ceiling support wires is not allowed.
3. Approved Products:
 - a. B-Line Cable Hook, BCHxx
 - b. B-Line Cable Hook, Cable to Beam Fastener, BCHxx-C2
 - c. B-Line Cable Hook, Cable to Fastener, 2", BCHxx-C442
 - d. B-Line Cable Hook, Cable to Rod Fastener, 2", BCHxx-W2

Where:

xx = 21 (1.25"), 32 (2"), or 64 (4")

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to section 27 00 00
- B. All installation shall be done in conformance with TIA-568 standards, BICSI methods, industry standards and manufacturer's installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable

bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

- C. Cabling between communications rooms and workstation locations are to be installed as individual "home runs". No intermediate punch down blocks or splices may be installed or utilized between the communications rooms and the information outlets at the workstation location.
- D. All cable must be handled with care during installation so as not to change performance specifications. Factory twists of each individual pair must be maintained up to the connection points at both ends of the cable. There shall never be more than .5 inches of unsheathed Category 6A UTP cable at either the wiring closet or the workstation termination locations.
- E. All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair equipment's efficient use of their full capacity.
- F. EMT or Conduit for pathways shall have no more than two 90-degree bends and no continuous section over 100'. Each conduit opening will be fitted with a nylon bushing to prevent damage to cables.
 - 1. Add hinged pull boxes to meet this requirement
- G. Provide cable tray to support main pathway cable bundles.
 - 1. Utilize J-Hooks as shown on drawing details to final device location.
- H. Exposed Cable
 - 1. All station cabling shall be installed inside walls or ceiling spaces whenever possible.
 - 2. Exposed station cable will only be run where indicated on the drawings and will only be allowed when no other options exist. Owner must approve all exceptions.
- I. Coordinate with other trades on whether there is a presence of variable frequency drive motors (VFD) being used above ceilings or at any location in the building, and if so, where their locations are.
 - 1. Route cabling away from VFD motors, maintaining a minimum of 6 feet from the motors.
- J. All cabling placed above drop ceilings must be supported by cable tray, conduit, or J-Hooks.
 - 1. Permanently affix cable supports to the building structure or substrates and provide attachment hardware and anchors designed for the structure to which attached and are suitably sized to sustain the weight of the cables to be supported.
 - 2. Attaching cable to pipes or other mechanical items is not permitted.
 - 3. Communication cables shall be routed so as to provide a minimum of 18 inches spacing whenever possible from light fixtures, sources of heat and EMI sources.
 - 4. Cabling shall not be attached to ceiling grid wires. Multiple cables are to be dressed every 4 feet.
 - 5. Support Cables on cable tray or J-hooks a minimum of every 4-feet
 - 6. Maximum cable sag between cable hooks is 3"-6".
 - 7. Plastic/nylon tie-wraps are not allowed to permanently secure cables inside the Telecommunications Rooms.
 - 8. All cabling installed above drop ceilings shall be installed a MAXIMUM of 12" above the finished ceiling

- K. Provide shall provide a 24-inch service loop above the access ceiling or cable trays unless specified otherwise. All service loops shall be 24 inches in diameter and be accessible for maintenance.
1. Coordinate loop placement and orientation with the technology consultant. This allows for future changes or expansion without installing new cables.
- L. Install cabling in cable trays and J-hooks by function and type of circuit.
1. Loosely lay cable in trays, segregating cable types. Do not use Velcro or cable ties to bundle cables.
 2. Only telecom cabling shall be installed in cable trays. No other low-voltage cabling is allowed within the cable tray.
- M. Identification:
1. Label cable terminations on designation strips.
 2. Label all cable at each terminating point.
 3. Label each port of the work area outlet.
 4. Cable identification numbers shall not be duplicated.
 5. Labeling convention to be coordinated with Owner.
 6. Label data patch panels and voice blocks in the communications rooms to match those on the corresponding voice and data outlets. The font shall be at least .125-inch in height.
 7. Where a wireless access point is installed above an acoustical ceiling, label the ceiling grid frame below the access point, displaying the data port number and, if applicable, the access point identification number. Coordinate with the Owner for all access point identification information.
 8. All labels shall correspond to as-built drawings and to final test reports.
 9. Coordinate with Owner for specifications on labeling of all hardware, cabling, and related equipment prior to any testing.
 10. Label each distribution rack, block and other terminating equipment unit and field within that unit within 4 inches from the block or patch panel termination. Keep labels in a neat and orderly lineup.
 11. Label each connector and each discrete unit of cable-terminating and connecting hardware within connector fields, in wiring closets and equipment rooms. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.
 12. Post the cable schedule in a prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations.
 13. Provide electronic copy of final comprehensive schedules for project in software and format selected by Owner.
 14. Refer to the following drawing for faceplate labeling:
 15. All cable labels shall:
 - a. Be marked at each end, on the sheath indicating the Telecommunications Room and jack number to which the cable is wired.
 - b. Backbone cables shall be marked at each endpoint and at all intermediate pull/access points or junction boxes. Label shall indicate origination and destination Telecommunication Rooms, sheath ID and strand or pair range.
 - c. Meet the legibility, defacement, exposure and adhesion requirements of UL 969.
 - d. Be pre-printed or laser printed type.
 - e. Where used for cable marking, a label with a vinyl substrate and white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable shall be provided. The label color shall be different than that of the cable to which it is attached.
 - f. Where insert type labels are used, provide clear plastic covers to go over label.

- g. The Contractor shall confirm specific labeling requirements with the Owner or Owner's Representative prior to cable installation or termination.

N. Documentation:

- 1. All cable inventory data documentation shall be submitted in format coordinated with and approved by Owner so that data can be incorporated into existing databases.
- 2. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.
- 3. Complete cross connect documentation is required. It shall include detailed documentation of each pair of all copper backbone cable and strand of fiber.

3.2 CLEANING

- A. All surfaces, cabling, and hardware shall be kept clean and free of dust and debris.
- B. Clean as needed and protect as required to maintain this requirement.

3.3 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and the Owner is satisfied that all work has been completed in accordance with contract documents, the Owner will notify Contractor in writing of formal acceptance of the system.
- B. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein.

3.4 WARRANTY

- 1. Provide CommScope SYSTIMAX full cabling solution 25-year warranty.
 - a. 25 Year Extended Product and Application Warranty (System Warranty)

REFER TO SECTION 27 00 00

END OF SECTION

SECTION 27 1600

COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Requirements for connecting cords, devices and adaptors, supplementing requirements found in the related sections.
- B. Related Sections
 - 1. 270000: Communications
 - 2. 270820: Copper Testing
 - 3. 271500: Communications Horizontal Cabling

1.2 WORK INCLUDED

- A. The Work of this Section shall consist of the labor, materials and equipment required for furnishing and installing telecommunications patch cables and equipment cords as part of a complete and functional telecommunications system.
- B. All items specified or included in this section shall be furnished and installed by Telecommunications Contractor, wired and connected by Telecommunications Contractor and tested by Telecommunications Contractor, unless noted otherwise. "Contractor" as used herein shall mean Telecommunications Contractor or Telecommunications Contractor's sub-contractor.
- C. Communications Patch Cords, Station Cords, and Cross-Connect Wire
 - 1. Data cable assemblies for the horizontal cross-connect and the workstation shall match horizontal, patch panel, and jack Category.
 - 2. Data cable assemblies shall be factory-assembled by the manufacturer of the cabling system.
 - 3. Provide data backbone factory-terminated fiber optic cable assemblies (Duplex LC to LC duplex) using duplex XG 850nm laser-optimized 50/125µm and Single-mode cable cross-connect assemblies in equipment rooms.
 - 4. Provide patch cord quantities on shop drawings.

1.3 COORDINATION

- A. Furnish and install the following:
 - 1. Patch and Equipment cords, for both copper and fiber.
- B. Electrical Contractor shall furnish and install the following:
 - 1. Floor boxes, box covers, straps.
 - 2. Boxes above ceilings and box covers.
- C. Unless noted, the following items will be the responsibility of the Owner:
 - 1. All electronics and active data networking equipment, etc.
 - 2. Telephones, fax machines and modems, etc.
 - 3. PC's, printers, video display terminals, flat panel displays, etc.
- D. Contact the Owner's network and computer equipment personnel for specific instructions before starting Work.

PART 2 - PRODUCTS

2.1 COPPER PATCH & EQUIPMENT CORDS

- A. Patch cables and equipment cords shall be factory pre-connectorized, TIA/EIA compliant matching horizontal cable specifications, 4 pair UTP, 8-position modular jack, and stranded conductors. Patch cables and equipment cords shall be able to withstand at least a minimum of 200 jack mating cycles without any transmission degradation.
- B. Provide all cords the same Category rating as cable, jacks and patch panels installed.
- C. Patch Cables For Equipment Rooms:
 - 1. Provide one box of (50) fifty five-foot **WHITE** cords for every voice patch panel
 - 2. Provide one box of seven-foot **BLUE** cords for every data patch panel.
- D. Provide equipment cords as necessary for the project with the following guidelines:
 - 1. Provide (1) one five-foot white plenum patch cord for every jack in above ceiling outlets
 - 2. Provide one 14-foot blue Cat6A cord for every data jack in every outlet. Provide one box of 50 7-foot green Cat6A patch cords. Provide twenty (20) 7-foot yellow Cat6A patch cords. Provide twenty (20) 20-foot yellow Cat6A patch cords.
 - 3. Coordinate with CLPCCD for list of other patch cords, lengths and quantities to be included in the project.
- E. Connection Reliability
 - 1. Use connectors with 50 μ m gold-plated tines (as specified by TIA standards), as well as designs that distance the connection point between the connector tines and plug from the arcing damage.
 - 2. Connectors should also meet contact resistance requirements found in the IEC 60512-99-001 standard covering connectors for electronic equipment.
- F. Manufacturer – CommScope Slimline cables

2.2 WET ENVIRONMENT PATCH CORDS

- A. Provide black CommScope Category 6A OSP patch cords, length as required, for every outlet / jack connecting to exterior communications devices (i.e. cameras, access points, etc).

2.3 FIBER OPTIC PATCH CORDS

- A. Provide the following:
 - 1. Six (6) 10-foot ST-LC duplex **RED** OM1 patch cords
 - 2. Six (6) 10-foot LC-LC duplex **RED** OM1 patch cords Provide duplex **YELLOW** TERASPEED single mode patch cords for data backbone.
 - 3. Six (6) 3-foot) single mode fiber SC-SC cords

PART 3 - EXECUTION

3.1 ADDITIONAL INFORMATION

- A. Refer to Section 27 00 00 for submittal and other general requirements

3.2 INSTALLATION

- A. Deliver patch cords to the Owner in factory sealed packages, requesting their sign-off on packages as delivered as specified.
 - 1. Coordinate on delivery timing with GC and Owner to ensure any circuits required for permit or occupancy certificates will be active and connected on time.

- B. Maintain bend radius of cables as recommended by the manufacturer and per BICSI standards.

END OF SECTION

SECTION 27 4100 - AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.1 PROJECT DESCRIPTION

- A. Project is at the Las Positas College at 3000 Campus Hill Dr in Livermore, CA 94551

1.2 DEFINITIONS

- A. Refer to Division 00 and 01 Specification Sections for project definitions.
- B. Refer to CLPCCD Cabling Infrastructure Standards.
- C. "AV" - Audiovisual
- D. "AV Contractor" - Company contracted to provide scope of work as described in this specification section.
- E. "Consultant" - Salter
- F. "District" – Las Positas College
- G. "Architect" – SmithGroup
- H. "AV Drawings" – "TA" and "AV" Series Drawings
- I. "OFE" - Owner-Furnished Equipment.
 - 1. Equipment furnished by District and installed by the AV Contractor as described in this specification section
- J. "GUI" - Graphical User Interface
- K. "GC" – General Contractor, Roebuck Construction

1.3 SCOPE OF WORK

- A. This specification section and associated AV Drawings provide a full description of AV Contractor scope of work.
- B. Refer to general conditions and drawings by others for related work. AV Drawings include infrastructure that may be provided by other divisions; verify AV Contractor scope of work with General Contractor prior to bidding.
 - 1. Refer to "TA" Series drawings for infrastructure to support AV systems that will be provided by GC.
- C. Refer to Divisions 00, 01, general conditions, and the following specification sections and drawing series for related work:
 - 1. Architectural
 - 2. Interiors
 - 3. Telecommunications

4. Security
 5. Electrical
- D. The following spaces require audiovisual installation under this scope of work:
1. B1800:
 - a. Engineering Materials 1802
 - b. Engineering Electrical 1805
 - c. Physics Lab 1807
 - d. Physiology 1810
 2. STEAM:
 - a. Microbiology 15109
 - b. Physiology 15105
 - c. Anatomy 15106
 - d. Anatomy 15104
 - e. Shared Learning Anatomy 15102
 - f. Cadaver 15104A
 - g. Photography Comp. Lab 15101C
 - h. Graphic Design Lab 15103
 - i. Intro Chem 15212
 - j. Intro Chem 15216
 - k. Gen Chem 15215
 - l. Gen Chem 15211
 - m. Organic Chem 15203
 - n. Painting Studio 15202
 - o. Drawing Studio 15204

1.4 SYSTEM DESCRIPTIONS

- A. Classrooms and Labs
1. Classrooms and Labs will be used for local instruction and learning.
 2. Ceiling-mounted projector(s) and 16:10 aspect ratio motorized projection screen(s).
 3. A wireless presentation device will allow instructors or students to cast content onto the projection screen from a variety of mobile and wireless devices.
 4. Ceiling-mounted loudspeakers for program audio and speech.
 5. An assistive listening system (ALS) will allow hearing-impaired students to hear program audio and speech.
 6. HDMI, USB-C, and DisplayPort at Instructor's desk for laptop computers, document cameras and other devices.
 7. Document camera
 8. Owl-Camera brought in as needed for conferencing.
 9. Touch-panel on Instructor's desk to allow control of AV system.
- B. Cadaver Room
1. (4) overhead closed circuit cameras in Cadaver Room above cadaver stations; password protected live camera-feeds accessible to Anatomy Room AV system touch-panels for projection or monitoring
- C. Conference Rooms
1. Conference rooms will be used for local and remote collaboration and communication.
 2. Wall-mounted display
 3. A wireless presentation device will allow instructors or students to cast content onto the projection screen from a variety of mobile and wireless devices.
 4. Video-conference-bar beneath display with microphone, camera, and speakers
 5. An assistive listening system (ALS) will allow hearing-impaired students to hear program audio and speech.

6. HDMI, USB-C, and DisplayPort at cable-cubby, served from wall-plate, for laptops
7. Touch-panel on conference table to allow control of AV system.

1.5 AV CONTRACTOR RESPONSIBILITY

- A. Furnish and install a complete and functioning audiovisual system including cabling, receptacle plates, loudspeakers, and electronic devices. Provide and install all components including the necessary equipment, interconnections, transducers, labor, and services required to meet specifications herein and as indicated on the drawings. Any item listed in the specification or shown on the drawings is to be included as part of this scope of work. Items specifically indicated on the drawings as "Not in Contract" are not to be provided.
- B. By bidding on this scope of work, the AV Contractor confirms that the system functionality described herein can be achieved with the equipment and conditions described. Additional labor, materials, or connections required are the responsibility of the AV Contractor. AV Contractor shall notify the District if it is believed the described system functionality cannot be achieved with the equipment or conditions identified in this scope of work.
- C. IT Coordination: Coordination as required with the District's IT representative where network related system configuration is required.
- D. Verify site conditions including dimensions, clearances, conduit sizes, and routing. Coordinate the exact location of the equipment with the architectural drawings. Report any conflicts that may interfere with systems installation.
- E. Verify that 120-volt AC power has been supplied near each equipment rack location, or any other location requiring AC power. Provide connection in flex-conduit from nearby AC power to equipment racks, where AC power receptacles are not located within the equipment rack enclosure. Provide and install all AC power receptacles within the equipment racks. Provide low-voltage turn-on controllers and switched outlets to activate and distribute AC power within the equipment racks.
- F. Notify the District's Representative in writing prior to AV installation of any penetrations at walls, ceilings and floors required for the installation of audiovisual equipment and cabling.
- G. Verify that the systems have been engineered prior to installation of suspended devices including, but not limited to, loudspeakers, microphones, flat panel monitors, video projectors, etc. Verify any attachment points and methods with licensed structural engineer prior to installation.
- H. Provide ventilation as required for equipment housed in millwork so that manufacturer-recommended temperatures are maintained during normal operating conditions.
- I. Conduct preliminary testing and adjustment. Submit documentation required by this specification. Participate in approval testing for acceptance. Perform final adjustments as required to meet specifications.
- J. Transfer all warranties and equipment guarantees and provide a written description of system operation to the District at the time of acceptance of the work by the District.
- K. Provide system operation training as described in this specification section.
- L. Provide "as-built" drawings of all systems, including modifications to the as-built infrastructure if any, on full sized sheets. Revisions are to be made to the actual CAD computer files (red

pen revision markups on paper drawing sheets are not acceptable) prior to print out. Provide CAD files on USB flash drive or storage format preferred by the District. Provide Control Panel and control system source code, DSP system configuration files, and all systems initial configuration preset files to Owner. Store files on site in the system documentation binders in disk sleeves.

- M. Owner Furnished Equipment: The AV Contractor shall be responsible for integrating owner-furnished equipment into the audiovisual systems as shown on the AV drawings.
- N. Perform all operations necessary to complete the installation.
- O. The audiovisual systems and components described in this specification section shall be free of any manufacturing, engineering, installation, or operational defects.
- P. AV Contractor shall provide installation that meets or exceeds applicable building codes.
- Q. System Programming and Graphical Interface Design
 - 1. The AV Contractor shall work with the District and/or Consultant to provide an agreed-upon GUI for all AV system Control Panel interfaces based on the District's standards.
 - 2. Provide all Control Panel, control system, audio DSP, and audiovisual processing equipment source code created for the project to the District upon system acceptance.
- R. Millwork
 - a. Coordinate audiovisual system components in millwork and furniture. Contractor shall perform all cutting, patching and painting as required, and shall repair any damage done as a result.

1.6 QUALITY ASSURANCE

- A. All materials must be newly manufactured current production models and must conform to all applicable codes and the relevant standards listed below:
 - 1. American National Standards Institute (ANSI)
 - 2. Electronic Industries Association (EIA)
 - 3. Institute of Electrical and Electronic Engineers (IEEE)
 - 4. Underwriters Laboratories (UL)
 - 5. "B" stock and/or refurbished items are not acceptable.
- B. Contractor Qualifications
 - 1. Experience: The AV Contractor will specialize in the installation of audiovisual systems in professional/commercial environments. Installers and engineers must individually have a minimum of five years of documented experience in the field of audiovisual system installation.
 - 2. Dealership: AV Contractor shall be an authorized dealer for all products listed, and shall perform any manufacturer training, certification, or other specialized requirements recommended by the manufacturer prior to installation. AV Contractor shall offer full factory warranty on all products provided.
 - 3. Certification: Bidder must have at least (1) employee staffed on the project in a supervisory role with either CTS-D or CTS-I certification from InfoComm International.
 - 4. Contractor shall be Crestron A+ Partner and shall honor Crestron A+ pricing structure.
 - 5. The AV contractor shall be trained and certified through the Crestron Technician/Field Engineer track, such that the completed installation is registered with Crestron for a 4-year advanced replacement/repair warranty.
- C. Supervision

1. The AV Contractor will designate a single supervisor to oversee the installation work for the duration of the project to ensure that the system is installed in accordance with the specification and drawings.
2. The supervisor will maintain adequate staff and be responsible for installing and testing the system on schedule.
3. The supervisor will have at least five years of documented, recent, and similar project experience.
4. The District reserves the right to make use of the system prior to the completion of the punch list. Temporary use of the equipment will not constitute an acceptance of the system or any part. The District will not pay additional cost to the AV Contractor and the commencement of the warranty period will not begin for the system or any device prior to the completion of the punch list and final acceptance of the system by the District.

D. Codes: AV Contractor will comply with all applicable laws, regulations and codes.

1.7 SUBMITTALS

A. Comply with submittal requirements Division 01 General Requirements.

B. Bid Submittals: Submit the following qualification documents:

1. Firm description.
2. Submit a list of authorized dealerships. The AV Contractor must be a dealer for any devices installed in this project to assure the installers are trained and that the dealer has a path for warranty repair as needed.
3. List of related projects: Related project list to include project name and location, description of project, contract amount, reference name and telephone number. One of the related projects must have been completed within the last 12 months.
4. Resumes of project supervisor documenting related experience. Project supervisor must have completed at least one installation in the past 12 months.
5. Names and scope of work for any subcontractors whose work would be part of this contract.
6. Clearly list and describe any deviations from and exceptions to the specifications or drawings.
7. As part of the AV Contractor's bid, a fully itemized list shall be provided showing the manufacturer's cost basis for each piece of equipment by room or system. This cost basis may be used by District to substitute in comparably priced up-to-date equipment that is brought to market after the construction submittal period.
8. Provide an optional price for maintenance contract extensions on an annual basis beyond the initial one-year warranty period.

C. Construction Submittals:

1. Submit complete equipment list by manufacturer, model number, and type. Include all accessories, options and functional components, and quantity to be supplied.
2. Equipment Substitutions
 - a. All submitted equipment must meet the minimum performance requirements shown in Part 2 of this specification.
 - b. Post-Submittal Equipment Update Substitutions: As there is a time gap between construction submittals and equipment installation, the District reserves the right to request substitutions of outdated equipment for updated equipment of a comparative class and cost basis. This arrangement is required of video projectors and flat panel displays. For video projectors, the contractor should attempt to provide substitutions to limit the number of different equipment manufacturer's for ease-of-maintenance considerations. Specified projector and

- flat panel mounting hardware will need to be re-evaluated to meet the requirements of the final projector selection.
3. Submit shop drawings for each building space included in this specification with the following drawings (as required by specific system):
 - a. Point-to-point functional wiring diagrams for all audio, video, control, and related signal system wiring diagrams. Must be connector pin-specific. Re-used Audiovisual Consultant design drawings with wire run numbers added are not acceptable for field construction use. Engineered drawings are not to have devices nor connections noted "typical". Show pin-specific wiring connections with wired numbers noted.
 - b. All receptacle plates and panels, including rack-mount panels labeling shown for engraving.
 - c. Equipment rack elevations.
 4. Submit shop drawings of any proposed design changes for approval prior to fabrication. Shop drawings are submitted for review and approval prior to fabrication and installation. Make submittals at least fifteen (15) working days prior to scheduled fabrication. Note on the submittal the dates of scheduled fabrication.
 5. Submit samples of engraved labels, cable marking system, and receptacle plate/panel etching.
 6. Acceptance Test Submittals: Prior to requesting the completion of the acceptance tests, submit Preliminary Test Report including all information required in Part 3. The AV Contractor is to provide a letter on company letterhead verifying that all devices and signal inputs have tested and are operable. This letter is to be signed by the project manager and sent to the consultant before acceptance testing can proceed.

1.8 PERMITS AND INSURANCE

1. Permits: Obtain any necessary permits for the execution of this work in conformance with applicable union regulations, local, State and Federal codes and regulations.
 - a. Insurance: Provide evidence of insurance for the full value of equipment and material located on site. Insurance will cover all losses until the work is formally accepted. Maintain additional liability insurance to protect the supplier and/or District against damage claims for personal injury, including death, which may arise during the performance of this work.

1.9 GUARANTEES AND WARRANTIES

- A. Transfer all manufacturer warranties to the District at the time of acceptance.
- B. Guarantee all installation work to be free of faulty workmanship. Guarantee all components and workmanship to be free from defects for a period of one year from the final date of acceptance, including solid-state devices.
 1. Provide an optional price for maintenance contract extensions on an annual basis beyond the initial one-year warranty period.
- C. Guarantee the replacement of faulty materials and workmanship within 48 hours of notification at no cost to the District if failure occurs during warranty period.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR AUDIOVISUAL PRODUCTS

- A. Materials listed herein represent specific minimum levels of performance and function. These levels of performance and function are as published by the listed manufacturers. All material

submitted shall be as listed or shall be substitutions that meet or improve upon the performance and functional characteristics of the listed material.

- B. If conflicts exist within the specification or between the specification and the drawings, contact the Consultant for clarification. Where listed quantities differ from that shown on drawings, assume the greater quantity and contact AV consultant for clarification.
- C. Equipment shall be procured from the original equipment manufacturer, or a manufacturer-approved dealer. If procured from a manufacturer-approved dealer, product(s) shall be supported at the same level as if procured from manufacturer.
- D. Repair or replace any equipment damaged during installation.

2.2 EQUIPMENT

- A. B1800:
 - a. **Engineering Materials 1802**
 - 1) OFE; use equipment procured by LPC; test existing cabling and provide new as necessary
 - b. **Engineering Electrical 1805**
 - 1) OFE; use equipment procured by LPC; test existing cabling and provide new as necessary
 - c. **Physics Lab 1807**
 - 1) OFE; use equipment procured by LPC; test existing cabling and provide new as necessary
 - d. **Physiology 1810**
 - 1) OFE; use equipment procured by LPC; test existing cabling and provide new as necessary
- B. STEAM:
 - a. **Digital Signage**
 - 1) Video Devices:
 - a) 65" Display: Samsung QM65C
 - b. **Physiology 15105 & Microbiology 15109**
 - 1) Cable & Hardware
 - a) Cable Cubbies: Extron Cable-Cubbies
 - b) Instructor Desk w/ Rack: Spectrum Industries 68020CHB
 - c) 12 Outlet Rackmount Power Strip: Tripp Lite RS1215-RA
 - d) Power Conditioner: Furman PL-Pro C
 - e) 24V Switching Power Supply: RDL PS-24AS
 - 2) Audio Devices
 - a) Ceiling loudspeakers: Crestron Saros IC6T
 - b) Crestron 70v Amplifier: AMP-2100-70
 - c) Line Level DA: RDL ST-DA3
 - d) Assistive Listening System: Listen Technologies RF/IR
 - e) Wireless Microphone Receiver: Shure ULXD4D
 - f) Wireless Microphone Body Pack: Shure ULXD1
 - g) Wireless Microphone Body Pack - Lav: WL185
 - h) Wireless Microphone Battery Charger: Shure SBC10-100-US
 - i) Wireless Microphone Battery: Shure SB900A
 - j) Audio DSP: [integral to Video Switcher]
 - 3) Video Devices:
 - a) Video Projector [1920 x 1200; WUXGA]: Panasonic PT-MZ882
 - b) Collaboration Monitors: Promethean ActivPanel 9 with ActivPanel stand, camera, and soundbar

- c) Video Switcher & Audio DSP: Crestron HD-PS622
- d) HDMI TX (box): Crestron DM-TX-4KZ-302-C
- e) HDMI RX (box): Crestron DM-RMC-4KZ-SCALER-C
- f) HDMI TX (wall-plate): Crestron DM-TX-4KZ-100-C-1G-B-T
- g) HDMI RX (wall-plate): Crestron DM-RMC-4K-100-C-1G-B-T
- h) HDMI/USB-C/DisplayPort Transmitter/Auto-switcher: Crestron HD-TX-4KZ-421-CHGR
- i) Wireless Presentation: Extron Sharelink Pro 2000
- j) Owl Camera: Owl Labs Meeting Owl 4+
- k) Document Camera: Wolfvision vSolution Cam
- l) Wacom Tablets: Wacom Cintiq Pro 16 [*for District Approval*]
- 4) Control Devices
 - a) Control Processor: Crestron RMC4
 - b) Touch-Panel: Crestron TSW-770
- c. **Anatomy 15104, 15106**
 - 1) Cable & Hardware
 - a) Cable Cubbies: Extron Cable-Cubbies
 - b) Instructor Desk w/ Rack: Spectrum Industries 68020CHB
 - c) 12 Outlet Rackmount Power Strip: Tripp Lite RS1215-RA
 - d) Power Conditioner: Furman PL-Pro C
 - e) 24V Switching Power Supply: RDL PS-24AS
 - 2) Audio Devices
 - a) Ceiling loudspeakers: Crestron Saros IC6T
 - b) Crestron 70v Amplifier: AMP-2100-70
 - c) Line Level DA: RDL ST-DA3
 - d) Assistive Listening System: Listen Technologies RF/IR
 - e) Wireless Microphone Receiver: Shure ULXD4D
 - f) Wireless Microphone Body Pack: Shure ULXD1
 - g) Wireless Microphone Body Pack - Lav: WL185
 - h) Wireless Microphone Battery Charger: Shure SBC10-100-US
 - i) Wireless Microphone Battery: Shure SB900A
 - j) Audio DSP: [integral to Video Switcher]
 - 3) Video Devices:
 - a) Video Projector [3840 x 2400; 4K]: Panasonic PT-REQ12
 - b) Collaboration Monitors: Promethean ActivPanel 9 with ActivPanel stand, camera, and soundbar
 - c) Video Switcher & Audio DSP: Crestron HD-PS622
 - d) HDMI TX (box): Crestron DM-TX-4KZ-302-C
 - e) HDMI RX (box): Crestron DM-RMC-4KZ-SCALER-C
 - f) HDMI TX (wall-plate): Crestron DM-TX-4KZ-100-C-1G-B-T
 - g) HDMI RX (wall-plate): Crestron DM-RMC-4K-100-C-1G-B-T
 - h) HDMI/USB-C/DisplayPort Transmitter/Auto-switcher: Crestron HD-TX-4KZ-421-CHGR
 - i) Wireless Presentation: Extron Sharelink Pro 2000
 - j) Owl Camera: Owl Labs Meeting Owl 4+
 - k) Document Camera: Wolfvision vSolution Cam
 - l) Wacom Tablets: Wacom Cintiq Pro 16 [*for District Approval*]
 - 4) Control Devices
 - a) Control Processor: Crestron RMC4
 - b) Touch-Panel: Crestron TSW-770
- d. **Shared Learning Anatomy 15102**
 - 1) Cable & Hardware
 - a) Cable Cubbies: Extron Cable-Cubbies
 - b) Instructor Desk w/ Rack: Spectrum Industries 68020CHB
 - c) 12 Outlet Rackmount Power Strip: Tripp Lite RS1215-RA

- d) Power Conditioner: Furman PL-Pro C
- e) 24V Switching Power Supply: RDL PS-24AS
- 2) Audio Devices
 - a) Ceiling loudspeakers: Crestron Saros IC6T
 - b) Crestron 70v Amplifier: AMP-2100-70
 - c) Line Level DA: RDL ST-DA3
 - d) Assistive Listening System: Listen Technologies RF/IR
 - e) Wireless Microphone Receiver: Shure ULXD4D
 - f) Wireless Microphone Body Pack: Shure ULXD1
 - g) Wireless Microphone Body Pack - Lav: WL185
 - h) Wireless Microphone Battery Charger: Shure SBC10-100-US
 - i) Wireless Microphone Battery: Shure SB900A
 - j) Audio DSP: [integral to Video Switcher]
- 3) Video Devices:
 - a) Touch-enabled 85" Display: Promethean Active Panel 9
 - b) Video Switcher & Audio DSP: Crestron HD-PS622
 - c) HDMI TX (box): Crestron DM-TX-4KZ-302-C
 - d) HDMI RX (box): Crestron DM-RMC-4KZ-SCALER-C
 - e) HDMI TX (wall-plate): Crestron DM-TX-4KZ-100-C-1G-B-T
 - f) HDMI RX (wall-plate): Crestron DM-RMC-4K-100-C-1G-B-T
 - g) HDMI/USB-C/DisplayPort Transmitter/Auto-switcher: Crestron HD-TX-4KZ-421-CHGR
 - h) Wireless Presentation: Extron Sharelink Pro 2000
 - i) Owl Camera: Owl Labs Meeting Owl 4+
 - j) Video-conference-bar: Logitech Rally Bar [for District Approval]
 - k) Document Camera: Wolfvision vSolution Cam
 - l) Wacom Tablets: Wacom Cintiq Pro 16 [for District Approval]
- 4) Control Devices
 - a) Control Processor: Crestron RMC4
 - b) Touch-Panel: Crestron TSW-770
- e. **Cadaver 15104A**
 - 1) Cable & Hardware
 - a) AV Rack: Middle Atlantic AX-SXR-15
 - 2) Video Devices:
 - a) HDMI/Fiber Cable: Kramer CP-AOCH/60
 - b) Video Matrix Switcher: Crestron DM-MD8x8-CPU3-RPS
 - c) HDMI DA: Crestron HD-DA2-4KZ-E
 - d) Control Processor: Crestron RMC4
 - e) Overhead Cadaver Cameras: *Integrated with Surgical Light (by others)*
 - f) Review Monitors: Crestron TSD-2220-B
 - g) Review Monitor Arm-Mount: Chief K2W120
- f. **Photography Comp. Lab 15101C**
 - 1) Cable & Hardware
 - a) Cable Cubbies: Extron Cable-Cubbies
 - b) Instructor Desk w/ Rack: Spectrum Industries 68020CHB
 - c) 12 Outlet Rackmount Power Strip: Tripp Lite RS1215-RA
 - d) Power Conditioner: Furman PL-Pro C
 - e) 24V Switching Power Supply: RDL PS-24AS
 - 2) Audio Devices
 - a) Ceiling loudspeakers: Crestron Saros IC6T
 - b) Crestron 70v Amplifier: AMP-2100-70
 - c) Line Level DA: RDL ST-DA3
 - d) Assistive Listening System: Listen Technologies RF/IR
 - e) Wireless Microphone Receiver: Shure ULXD4D
 - f) Wireless Microphone Body Pack: Shure ULXD1

- g) Wireless Microphone Body Pack - Lav: WL185
- h) Wireless Microphone Battery Charger: Shure SBC10-100-US
- i) Wireless Microphone Battery: Shure SB900A
- j) Audio DSP: [integral to Video Switcher]
- 3) Video Devices:
 - a) Video Projector [3840 x 2400; 4K]: Panasonic PT-REQ12
 - b) Collaboration Monitors: Promethean ActivPanel 9 with ActivPanel stand, camera, and soundbar
 - c) Video Switcher & Audio DSP: Crestron HD-PS622
 - d) HDMI TX (box): Crestron DM-TX-4KZ-302-C
 - e) HDMI RX (box): Crestron DM-RMC-4KZ-SCALER-C
 - f) HDMI TX (wall-plate): Crestron DM-TX-4KZ-100-C-1G-B-T
 - g) HDMI RX (wall-plate): Crestron DM-RMC-4K-100-C-1G-B-T
 - h) HDMI/USB-C/DisplayPort Transmitter/Auto-switcher: Crestron HD-TX-4KZ-421-CHGR
 - i) Wireless Presentation: Extron Sharelink Pro 2000
 - j) Owl Camera: Owl Labs Meeting Owl 4+
 - k) Document Camera: Wolfvision vSolution Cam
 - l) Wacom Tablets: Wacom Cintiq Pro 16 [*for District Approval*]
- 4) Control Devices
 - a) Control Processor: Crestron RMC4
 - b) Touch-Panel: Crestron TSW-770
- g. **Graphic Design Lab 15103**
 - 1) Cable & Hardware
 - a) Cable Cubbies: Extron Cable-Cubbies
 - b) Instructor Desk w/ Rack: Spectrum Industries 68020CHB
 - c) 12 Outlet Rackmount Power Strip: Tripp Lite RS1215-RA
 - d) Power Conditioner: Furman PL-Pro C
 - e) 24V Switching Power Supply: RDL PS-24AS
 - 2) Audio Devices
 - a) Ceiling loudspeakers: Crestron Saros IC6T
 - b) Crestron 70v Amplifier: AMP-2100-70
 - c) Line Level DA: RDL ST-DA3
 - d) Assistive Listening System: Listen Technologies RF/IR
 - e) Wireless Microphone Receiver: Shure ULXD4D
 - f) Wireless Microphone Body Pack: Shure ULXD1
 - g) Wireless Microphone Body Pack - Lav: WL185
 - h) Wireless Microphone Battery Charger: Shure SBC10-100-US
 - i) Wireless Microphone Battery: Shure SB900A
 - j) Audio DSP: [integral to Video Switcher]
 - 3) Video Devices:
 - a) Video Projector [3840 x 2400; 4K]: Panasonic PT-REQ12
 - b) Collaboration Monitors: Promethean ActivPanel 9 with ActivPanel stand, camera, and soundbar
 - c) Video Switcher & Audio DSP: Crestron HD-PS622
 - d) HDMI TX (box): Crestron DM-TX-4KZ-302-C
 - e) HDMI RX (box): Crestron DM-RMC-4KZ-SCALER-C
 - f) HDMI TX (wall-plate): Crestron DM-TX-4KZ-100-C-1G-B-T
 - g) HDMI RX (wall-plate): Crestron DM-RMC-4K-100-C-1G-B-T
 - h) HDMI/USB-C/DisplayPort Transmitter/Auto-switcher: Crestron HD-TX-4KZ-421-CHGR
 - i) Wireless Presentation: Extron Sharelink Pro 2000
 - j) Owl Camera: Owl Labs Meeting Owl 4+
 - k) Document Camera: Wolfvision vSolution Cam
 - l) Wacom Tablets: Wacom Cintiq Pro 16 [*for District Approval*]

- 4) Control Devices
 - a) Control Processor: Crestron RMC4
 - b) Touch-Panel: Crestron TSW-770
- h. **Intro Chem** 15212, 15216
 - 1) Cable & Hardware
 - a) Cable Cubbies: Extron Cable-Cubbies
 - b) Instructor Desk w/ Rack: Spectrum Industries 68020CHB
 - c) 12 Outlet Rackmount Power Strip: Tripp Lite RS1215-RA
 - d) Power Conditioner: Furman PL-Pro C
 - e) 24V Switching Power Supply: RDL PS-24AS
 - 2) Audio Devices
 - a) Ceiling loudspeakers: Crestron Saros IC6T
 - b) Crestron 70v Amplifier: AMP-2100-70
 - c) Line Level DA: RDL ST-DA3
 - d) Assistive Listening System: Listen Technologies RF/IR
 - e) Wireless Microphone Receiver: Shure ULXD4D
 - f) Wireless Microphone Body Pack: Shure ULXD1
 - g) Wireless Microphone Body Pack - Lav: WL185
 - h) Wireless Microphone Battery Charger: Shure SBC10-100-US
 - i) Wireless Microphone Battery: Shure SB900A
 - j) Audio DSP: [integral to Video Switcher]
 - 3) Video Devices:
 - a) Video Projector [1920 x 1200; WUXGA]: Panasonic PT-MZ882
 - b) Collaboration Monitors: Promethean Roll-in
 - c) Video Switcher & Audio DSP: Crestron HD-PS622
 - d) HDMI TX (box): Crestron DM-TX-4KZ-302-C
 - e) HDMI RX (box): Crestron DM-RMC-4KZ-SCALER-C
 - f) HDMI TX (wall-plate): Crestron DM-TX-4KZ-100-C-1G-B-T
 - g) HDMI RX (wall-plate): Crestron DM-RMC-4K-100-C-1G-B-T
 - h) HDMI/USB-C/DisplayPort Transmitter/Auto-switcher: Crestron HD-TX-4KZ-421-CHGR
 - i) Wireless Presentation: Extron Sharelink Pro 2000
 - j) Owl Camera: Owl Labs Meeting Owl 4+
 - k) Document Camera: Wolfvision vSolution Cam
 - l) Wacom Tablets: Wacom Cintiq Pro 16 [*for District Approval*]
 - 4) Control Devices
 - a) Control Processor: Crestron RMC4
 - b) Touch-Panel: Crestron TSW-770
- i. **Gen Chem** 15211, 15215, & **Organic Chem** 15203
 - 1) Cable & Hardware
 - a) Cable Cubbies: Extron Cable-Cubbies
 - b) Instructor Desk w/ Rack: Spectrum Industries 68020CHB
 - c) 12 Outlet Rackmount Power Strip: Tripp Lite RS1215-RA
 - d) Power Conditioner: Furman PL-Pro C
 - e) 24V Switching Power Supply: RDL PS-24AS
 - 2) Audio Devices
 - a) Ceiling loudspeakers: Crestron Saros IC6T
 - b) Crestron 70v Amplifier: AMP-2100-70
 - c) Line Level DA: RDL ST-DA3
 - d) Assistive Listening System: Listen Technologies RF/IR
 - e) Wireless Microphone Receiver: Shure ULXD4D
 - f) Wireless Microphone Body Pack: Shure ULXD1
 - g) Wireless Microphone Body Pack - Lav: WL185
 - h) Wireless Microphone Battery Charger: Shure SBC10-100-US
 - i) Wireless Microphone Battery: Shure SB900A

- j) Audio DSP: [integral to Video Switcher]
- 3) Video Devices:
 - a) Video Projector [1920 x 1200; WUXGA]: Panasonic PT-MZ882
 - b) Collaboration Monitors: Promethean ActivPanel 9 with ActivPanel stand, camera, and soundbar
 - c) Video Switcher & Audio DSP: Crestron HD-PS622
 - d) HDMI TX (box): Crestron DM-TX-4KZ-302-C
 - e) HDMI RX (box): Crestron DM-RMC-4KZ-SCALER-C
 - f) HDMI TX (wall-plate): Crestron DM-TX-4KZ-100-C-1G-B-T
 - g) HDMI RX (wall-plate): Crestron DM-RMC-4K-100-C-1G-B-T
 - h) HDMI/USB-C/DisplayPort Transmitter/Auto-switcher: Crestron HD-TX-4KZ-421-CHGR
 - i) Wireless Presentation: Extron Sharelink Pro 2000
 - j) Owl Camera: Owl Labs Meeting Owl 4+
 - k) Document Camera: Wolfvision vSolution Cam
 - l) Wacom Tablets: Wacom Cintiq Pro 16 [*for District Approva*]
- 4) Control Devices
 - a) Control Processor: Crestron RMC4
 - b) Touch-Panel: Crestron TSW-770
- j. **Painting Studio 15202 & Drawing Studio 15204**
 - 1) Cable & Hardware
 - a) Cable Cubbies: Extron Cable-Cubbies
 - b) Instructor Desk w/ Rack: Spectrum Industries 68020CHB
 - c) 12 Outlet Rackmount Power Strip: Tripp Lite RS1215-RA
 - d) Power Conditioner: Furman PL-Pro C
 - e) 24V Switching Power Supply: RDL PS-24AS
 - 2) Audio Devices
 - a) Ceiling loudspeakers: Crestron Saros IC6T
 - b) Crestron 70v Amplifier: AMP-2100-70
 - c) Line Level DA: RDL ST-DA3
 - d) Assistive Listening System: Listen Technologies RF/IR
 - e) Wireless Microphone Receiver: Shure ULXD4D
 - f) Wireless Microphone Body Pack: Shure ULXD1
 - g) Wireless Microphone Body Pack - Lav: WL185
 - h) Wireless Microphone Battery Charger: Shure SBC10-100-US
 - i) Wireless Microphone Battery: Shure SB900A
 - j) Audio DSP: [integral to Video Switcher]
 - 3) Video Devices:
 - a) Collaboration Monitors: Promethean ActivPanel 9 with ActivPanel stand, camera, and soundbar
 - b) Video Switcher & Audio DSP: Crestron HD-PS622
 - c) HDMI TX (box): Crestron DM-TX-4KZ-302-C
 - d) HDMI RX (box): Crestron DM-RMC-4KZ-SCALER-C
 - e) HDMI TX (wall-plate): Crestron DM-TX-4KZ-100-C-1G-B-T
 - f) HDMI RX (wall-plate): Crestron DM-RMC-4K-100-C-1G-B-T
 - g) HDMI/USB-C/DisplayPort Transmitter/Auto-switcher: Crestron HD-TX-4KZ-421-CHGR
 - h) Wireless Presentation: Extron Sharelink Pro 2000
 - i) Owl Camera: Owl Labs Meeting Owl 4+
 - j) Document Camera: Wolfvision vSolution Cam
 - k) Wacom Tablets: Wacom Cintiq Pro 16 [*for District Approva*]
 - 4) Control Devices
 - a) Control Processor: Crestron RMC4
 - b) Touch-Panel: Crestron TSW-770

- C. Projection Screens
 - 1. Da-Lite Tensioned Advantage Electrol 116" x 72.5" with 2" black-drop minimum
 - a. Graphic Design Lab 15103
 - b. Physiology 15105
 - c. Microbiology 15109
 - d. Anatomy 15106
 - e. Anatomy 15104
 - f. Photography Comp Lab 15101C
 - g. Intro Chem 15212
 - h. Intro Chem 15216
 - i. Gen Chem 15215
 - j. Gen Chem 15211
 - k. Organic Chem 15203
 - 2. Da-Lite Tensioned Advantage Electrol 96" x 60" with 2" black-drop minimum
 - a. Physics Lab 1807
 - 3. Da-Lite Tensioned Advantage Electrol 84" x 50" with 2" black-drop minimum
 - a. Physiology 1810

2.3 MISCELLANEOUS HARDWARE

- A. Terminal cabinets and boxes: terminal cabinets, mud-rings, and junction boxes housing audio cabling shall be metallic. Terminal cabinets shall be verified for size by AV Contractor prior to beginning job-site work. Size cabinets for required base-bid wiring fill. Allow forty percent (40%) additional capacity for future system growth.
- B. Provide matching manufacturer vents and blanks as required.
- C. Rack Connections: AC power cables to the power strips shall be run in steel conduit. All in-going and out-going signal cabling shall be run in conduit or cabling pathways independent of AC power cabling.
- D. Connectors: Provide compatible plugs as indicated on the receptacle plate drawing sheets; all cable connectors shall have black anodized finish where available unless otherwise noted. Connector parts subject to any possible structural loading or stress shall be metal.
- E. Conduit: Provide removable seals at penetrations for acoustic isolation.
- F. Audiovisual System Faceplates: Silk-screened and coated lettering shall identify individual plate mounted receptacles. Connector identification shall denote function and unique input/output number. Lettering shall be centered above appropriate connector. Connector mounting will allow sufficient finger clearance for connector insertion and removal without interference from adjacent connectors.
- G. Receptacle Plates:
 - 1. Receptacle plates shall be steel or aluminum with etched and ink filled labeling. Confirm plate color preferences and requirements with District prior to fabrication or ordering. Plates ordered without District approval may be replaced at AV Contractor's expense. Refer to AV Drawings for specific plate connector requirements.
 - 2. Center lettering vertically over appropriate connector. Connector mounting shall allow sufficient finger clearance for connector insertion and removal without interference from adjacent connectors.
 - 3. Engraved plastic labels fastened with epoxy are acceptable only where custom engraving options are not available from manufacturer, and only with approval by the District.

- H. Provide black Techflex cable wrap as required for cable umbilical bundles.
- I. Provide acoustical insulation such as Rock Wool or acoustic cotton such as UltraTouch for loudspeakers mounted in wall cavities.
- J. Electronic component faceplate labels: Provide permanent labels on equipment to identify device, system, or control function as appropriate for operational purposes. All control knob and switch labels shall be located vertically adjacent over the appropriate control. Engraved plastic labels fastened with epoxy are acceptable. Dymo type labels are not acceptable.
- K. Rack Equipment
 - 1. Provide placard at each AV equipment rack that states "Designed by Salter & Installed by _____ (AV Contractor name with phone and website). For repairs call _____ (AV Contractor name with phone)." Provide as either a rackmount panel, or as a placard attached to one of the equipment racks in each major control room equipment location.
 - 2. Rack-mounted blank plates.

2.4 PRE-MANUFACTURED CABLES

- A. Pre-Manufactured Cables for Receptacle Plates (HDMI, Audio): Provide one cable with connectors for every end-user receptacle to connect laptop computers, and other portable audiovisual source devices:
 - 1. Gold-Plated Connectors
 - 2. NEC CL2 rated non-plenum
 - 3. HDMI/DVI Input: Cables must be rated for HDMI 2.0a specifications or better, capable of passing required resolutions, frame rates, and color space at distances under 10' without an active equalizer.
 - 4. Audio: 20 to 20Khz
 - 5. Recommended Equipment: Extron, various models.
- B. HDMI(F)-to-Display Port(M) Adapter: For every pre-manufactured HDMI cable provided, provide an adapter for Display Port source devices.

2.5 INSTALLATION CABLE – ALL SPACES

- A. Loudspeaker Cable (8 or 4 ohm, less than 500 watts): West Penn Wire C207 (12 AWG, unshielded pair) or equal
- B. Distributed Non-Plenum Loudspeaker Cable (70volt, less than 60-Watt tap): Belden 1309A (14 AWG, unshielded pair) or equal.
- C. Distributed Plenum Rated Loudspeaker Cable (70volt, less than 60-Watt tap): Belden 6100UE (14 AWG, unshielded pair) or equal.
- D. Analog Microphone/Line Level Installation Cable: Belden model# 9464 (20 AWG conductor, jacketed, shielded, twisted-pair) or equal.
- E. Analog Microphone/Line Level Installation Cable (Dining Room inputs, high noise rejection): Mogami W2534 (24AWG 4-conductor, jacketed, shielded, twisted-pair) or equal.
- F. Analog Microphone/Line Level Equipment Rack Interconnect Cable: Belden model# 8450 (22 AWG conductor, jacketed shielded, twisted-pair) or equal.

- G. Antenna Cable: Conductor is 13 AWG (RG8/U) covered by braided shield. JSC model# 3040 or equal. Provide co-axial cable whose impedance matches devices requiring 50ohm antenna connection.
- H. Digital Media Cable: DM-CBL-8G-NP-SP500
- I. Pre-Terminated HDMI cables: Extron, Atlona, or equal. (Note, cables must be rated for HDMI 1.3a specifications or better, capable of passing 1080p or 1920x1200 resolution at distances under 10' without an active equalizer.)
- J. Control System Device Control Cables (RS232, RS422, Serial (IR), Relay or Contact Closure): Supply pre-terminated serial control cables within equipment racks. Provide West Penn Wire 1992 (4 pair) signal cable, or equal for relay or contact closure application, as required.
- K. Network and twisted pair Cable for AV Signal Extenders: Provide project network standard Category 6 cable, or equal.
- L. All cabling shall be rated for the environment for which it is placed.
- M. Provide plenum rated cable for all cable where required by code. Any cable changes or substitutions must be submitted and approved prior to installation. Cable that has been installed without approval is replaced at the AV Contractor's expense.
- N. For HDMI runs over 25' AV Contractor shall provide HDMI over shielded CAT6 extension system.
- O. Cable installed without District approval may be replaced at the AV Contractor's expense.
- P. Acceptable Cable Manufacturers:
 - 1. Liberty
 - 2. Belden
 - 3. West Penn
 - 4. Canare
 - 5. Mogami
 - 6. Extron
 - 7. Crestron
 - 8. Windy City Wire

2.6 CONNECTORS

- A. Audio 1/4" panel-mount connector: Switchcraft 1/4" TS, solder back, or equal.
- B. Loudspeaker Connectors: Neutrik 4-Pole Speakon series.
- C. HD-SDI, Composite Video, Genlock (Sync), SMPTE BNC panel-mount connector: Provide a panel-mounted BNC jack with isolated ground bulkhead and compatible connector. Supply Canare BCP-C5FA male, or equal.
- D. Antenna connector: Provide receptacle plate-mounted general-purpose UHF antenna connector. Coaxial bulkhead connector will match impedances of antenna cable and match style of connector on device requiring antenna. Supply Amphenol 83-1f.

- E. RS232/Control D-Shell Panel-Mount Connector: Mouser D-sub series, or equal.
 - F. Specialty RJ45 connectors (UTP Extenders, etc.): Supply Neutrik Ethercon series connectors where AV connections are to be terminated at AV receptacle plates and panels.
 - G. CAT6 8-Pin Modular Chassis Connector at Receptacle Plates
 - 1. CAT6 Compliant up to 10GBits/s
 - 2. CAT6 specifications according TIA / EIA 568B, ISO / IEC 11801, EN 50173
 - 3. Push Pull mating - secure and proven locking system
 - 4. Ground lead jumper on panel connector with selectable grounding option
 - 5. Gas-tight IDC termination without tool
 - 6. Recommended equipment: Neutrik NE8FDY-C6-B
- 2.7 FINISHES
- A. All enclosures, housings and fixtures supplied by the AV Contractor not having a standard factory protective finish are to be painted. Paint specifications are to be supplied by the Architect or indicated herein.
 - B. Any equipment or materials supplied which are exposed to public view are to be approved by the District. Provide, as required by the District, custom color and/or finish for publicly-visible devices, if available.

PART 3 - EXECUTION

3.1 GENERAL DESCRIPTION

- A. The following is required for acceptance of the audiovisual system by the District:
 - 1. Install complete and functioning audiovisual system specified.
 - 2. Label equipment and cables as specified and corresponding to functional diagram.
 - 3. Conduct adjustments and preliminary testing.
 - 4. Report results of preliminary testing along with system documentation.
 - 5. Participate in acceptance test and deliver final system and documentation.
 - 6. Conduct any adjustments or re-testing that is required to adhere to the specifications.
 - 7. Provide training to individuals designated by the District.
- B. Installation shall meet or exceed industry standards and best practices, including, but not limited to, those described in the following publications:
 - 1. InfoComm International
 - a. "Basics of Audio and Visual Systems Design"
 - b. "AV Installation Handbook"
 - c. "AV Implementation Handbook"
 - 2. Building Industry Consulting Service International (BiCSi), "Telecommunications Distributions Methods Manual" (TDMM)
 - 3. Telecommunications Industry Association/Electronic Industries Alliance (TIA/EAI), "TIA/EIA Wiring Standards"

3.2 GENERAL REQUIREMENTS

- A. All equipment except portable equipment shall be held firmly in place. This includes racks, conduits, cables, receptacle plates and panels, and all electronic equipment. The District shall approve structural fastenings and supports.

- B. Submit shop drawings for custom fabrications including custom panels, receptacle plates, patch panel layouts, and rack elevations to the District for review and approval. Make submittals at least fifteen (15) days prior to scheduled fabrication. Note on the submittal the dates of scheduled fabrication. Submittal responses is expedited due to the compressed installation schedule.
- C. Do not commence work on any portion of the project requiring District 's approval prior to obtaining such approval. Work commenced and installed prior to review and approval shall be accepted at the District's discretion. Installation does not imply acceptance or review for acceptance.
- D. Keep at the job site an up-to-date complete record set of prints and specification. Make daily corrections and show all changes from the original contract drawings. Final as-built drawings are required at the conclusion of the project.
- E. Keep the job adequately staffed at all times. A qualified engineer approved by the District and employed by the AV Contractor shall exercise engineering supervision over the entire installation. Unless through illness, loss of personnel, or other circumstances beyond the control of the AV Contractor, keep the same individual in charge throughout the execution of the work.
- F. Execute, without claim for additional payment, moderate moves or changes as necessary or required by the District prior to installation to accommodate minor design changes, rack layout changes, or to preserve symmetry and pleasing appearance.
- G. Conduct preliminary testing and adjustment. Submit documentation required by this specification. Participate in approval testing for acceptance. Perform final adjustments as required to meet specifications.
- H. Deliver bound "as-built" system documentation. Transfer all warranties and equipment guarantees and provide a written description of system operation to the District at the time of acceptance of the work by the District. Provide system operation training as specified in Section 3.6.

3.3 INSTALLATION REQUIREMENTS

- A. General
 - 1. All equipment and cabling shall be installed in accordance with manufacturer recommendations, in a clean, neat, and organized fashion.
 - 2. Equipment requiring service or routine adjustments, such as equipment racks, shall be accessible for such services.
 - 3. All permanently installed equipment shall be plumb and square, and firmly held in place.
 - 4. Contractor shall take appropriate measures to minimize electromagnetic and/or electrostatic interference. Install all equipment and cabling with regard for minimization of induced electromagnetic and electrostatic noise.
 - 5. Cables and wiring in racks, consoles, connector boxes and on terminal strips shall be clearly marked between 2" and 4" from end of cable gasket/harness. Provide maximum label visibility. Indicate the signal type, wire number, source and destination and jack, receptacle or socket to which connector should be mated. Use appropriate diameter clear shrink tubing over surface of label for protection and permanence. Extend shrink tubing over label by approximately 1/4" at each end.

6. Contractor shall provide appropriate protection for equipment and related wiring in locations where extreme environmental conditions may occur.
 7. All audiovisual point-to-point signal cable is to be run in cabling pathways separate of AC power and network data conduit, except where identified on drawings.
 8. Verify that all AC power circuits designated for audiovisual equipment, both fixed-in-place and portable, are properly wired, phased and grounded. Report any discrepancies found to the District.
 9. Verify with District where secure attachments, such as Kensington locks or projector locks, are required for audiovisual equipment in public spaces due to theft or vandalism concerns. Provide such attachments where required.
 10. Confirm finish color of publicly visible devices, such as loudspeakers, with District and/or Architect prior to ordering. Any publicly visible devices installed without prior approval may be replaced at the AV Contractor's expense.
- B. Mounting
1. All permanently mounted equipment shall be attached to the structure and held firmly in place. Provide brackets, braces and supports as required. Verify mounting with structural engineer prior to installation.
 2. Provide for (5) degrees of adjustability for any angular orientation shown in drawings.
 3. Verify structural mounting, backing, and reinforcement points prior to installation.
 4. Provide trim/escutcheon hardware for hardware penetrating finished ceilings. Verify finishes of trim components with Architect prior to ordering.
- C. Cabling
1. General
 - a. All cabling shall be continuous and without splices.
 - b. Maintain proper positive/negative phase between all points in the system.
 - c. Use care in wiring to avoid damage to cables. Where required, use temporary guides, sheaves, rollers, or other necessary devices to protect cables from excess tension, abrasion, bending, or any other damage during pulling. Provide wire pulling lubricants in accordance with wire and cable manufacturer's recommendations.
 - d. Spacing between cable ties or is to be no less than six (6) inches.
 - e. Provide rubber or nylon grommets over edges of cable pass through holes in chassis, racks, boxes, plates, etc.
 - f. Provide ample service loops at cable endpoints so that plates, panels, and equipment can be demounted for inspection. Where no rear access to cable termination points on equipment exists, provide sufficient length of cabling so that equipment may be easily removed independent of other equipment.
 - g. No length of cable over 18", with the exception of service loops, shall be unsupported by wire-way, raceway, conduit, or other approved cable support.
 - h. Equipment that is to be moved during normal operation, such as slide-out shelves, shall be provided with adequate cable lengths to accommodate the full range of travel in each direction, and shall be dressed to avoid pinching or wedging in moving parts.
 - i. Install cabling so that there is at least 6" of separation between circuits carrying AC power.
 - j. Where cabling of different signal types must cross, they are to do so perpendicularly as to minimize interference from one another.
 - k. Bending radii shall be minimum of (10) times the outer diameter of the cable jacket
 - l. Conduit fill ratios are not to exceed 40% of internal conduit area.
 2. Termination
 - a. All connections to jacks and connectors shall employ rosin-core solder, with no cold joints or splatter.

- b. Except for the case of screw terminals, all bare wire conductors are to be tinned with resin flux.
 - c. Screw-terminated conductors shall be wrapped in the same direction as screw rotation when tightening.
 - d. Provide clear shrink tubing sleeve over each individual wire termination and solder lug. All exposed shield drain wire shall be sheathed in properly sized clear shrink tubing sleeves and protected against shorting to other conductors or connector shells.
3. Labeling/Identification
- a. All cabling shall be permanently labeled with unique numbers using wire makers printed via computer software program. Maintain consistent labeling practices across all cabling, including numbering, signal type identification, and text direction. Provide "run sheets" listing all cables by number, signal type, and termination type on both ends. Labeling information is to include the following:
 - b. Cabling for audiovisual systems shall be of a different jacket color than other low-voltage cabling where pathways are shared between divisions or other systems.
4. Audio
- a. Audio system shall be free of audible hum, noise, buzz, and distortion.
 - b. Balanced audio connectors shall be terminated in accordance with the international (IEC) standard: Pin 1: shield, Pin 2: audio positive, and Pin 3: audio negative.
 - c. All audio signal conductors connected between active devices shall be electronically balanced or transformer balanced with respect to the audio signal ground. Unbalanced audio circuits, where possible, shall utilize level matching interfaces with active balanced circuitry or isolation transformers.
 - d. When connecting unbalanced and balanced line-level signals, refer to RaneNote 110: "Sound System Interconnection" for proper wiring techniques.
 - e. Where there are unused conductors in a cable assembly, fold unused cables along outer jacket and cover completely with heat-shrinkable tubing.
 - f. Microphone and line level signal cabling shall be installed at least 3" from other low-voltage cabling
 - g. Bridle rings suspended from ceiling or shared cable tray shall be provided in conditions where audio cabling is to share cable tray or pathways with other low-voltage cabling.
- D. Equipment Racks
- 1. Cabling within equipment racks shall be neatly bundled and laced. AV Contractor shall, at no additional cost, re-bundle and lace cabling if directed by District and/or Consultant. Utilize cable tie-bars as necessary. Harnessed cables are to be combed straight.
 - 2. Placement of equipment in equipment racks, as shown in the drawings, is for operator convenience, ventilation and/or circuit flow. Verify any changes in placement of the equipment with the Consultant prior to assembly.
 - 3. Provide ventilation adequate to keep temperatures within equipment racks below 90 degrees F. Provide approved passive and/or active ventilation as required.
 - 4. Racks shall be installed plumb and square within the room, and without twists in the frames or variations in level between adjacent racks.
 - 5. Custom panels shall be manufactured in order to prevent panel deformation during normal plugging and switching operations.
 - 6. Equipment requiring user interface shall be mounted between 18" and 48" AFF.
 - 7. The front and rear of each rack-mounted device shall be labeled with labels (i.e. "Video Switcher #"); as well as all occupied slots in card frame devices.
 - 8. Mount equipment using equipment rack manufacturer-approved black machine screws with nylon washers.

9. Heavy and/or deep equipment shall be provided with additional mounting hardware to support rear of equipment.
 10. Unless otherwise shown on AV Drawings, heavy equipment, such as amplifiers, shall be mounted towards the bottom of the rack.
 11. Provide code-required seismic restraints as necessary.
 12. Electrical Requirements:
 - a. Where power sequencing devices are required, the following On/Off sequencing shall be provided:
 - b. Control system components shall remain powered up and functional to accept control system commands.
 - c. Audio amplifiers and/or powered loudspeakers are to power up last and power down first to prevent loudspeaker damage.
 - d. Sequence the turn-on of devices so that AC power in-rush current is minimized.
- E. Loudspeakers
1. Provide structural support for wall and ceiling-suspended loudspeakers.
 2. Adjust distributed loudspeaker transformer taps, audio DSP, and amplifier levels for uniform consistency in sound pressure level throughout serviced area(s).
 3. Orient loudspeakers for optimal coverage of intended listening area. Perform adjustments as required to optimize coverage uniformity.
 4. Provide rigid support members to prevent loudspeaker from moving during operation after final adjustments have been made.
 5. Provide jumper configuration on Atrium Loudspeakers to optimize coverage to the stair seating.
- F. Video Projectors and Monitors
1. AV Contractor shall review and assess field conditions and select video projector lens(es) with appropriate focal lengths prior to ordering. The image is to completely fill the screen. The AV Contractor shall adjust video projector(s) and lens(es) for optimal picture quality, including lens focus, lens shift, and keystone adjustments.
 2. Refer to AV Drawings for video projection screen sizes and locations.
 3. Provide full video projector and monitor calibration, configuration, and adjustments for all used inputs. Adjust aspect ratio configuration so that all installed sources fill the projection screen completely, without unnecessary scaling or stretching.
 4. Configure EDID settings for all analog and digital video sources as required for proper compatibility between video sources. Video scaling is to be minimized as much as possible, so that a video source is scaled no more than (1) time within the overall system.
 5. Provide a query command via bi-directional protocol (serial or network) regarding projector lamp life, and provide a means to display that lamp life, either on a Control Panel display at start-up, or via network settings that send notifications to appropriate maintenance staff. Coordinate with District regarding desired notification format.
 6. Video monitors shall be set to initiate "Standby" mode when no input source is detected and return to "On" state once a video source is detected.
- G. Wireless AV Systems
1. Verify available wireless RF frequencies on site over a 24-hour period prior to ordering any wireless RF equipment, including wireless microphone or hearing assistance systems. Verify frequency selection with manufacturer. If available frequency spectrum does not allow for the use of specific wireless RF components, notify District in writing.
 2. Coordinate frequencies of all wireless devices, including District-provided devices.
 3. Locate wireless microphone receiver antennas for adequate signal reception. Provide additional antennas, amplifiers, Bias-Ts, or any other devices as required to ensure

adequate signal reception in the intended area. If the intended area is unclear, verify with Consultant prior to installation.

- H. Portable Equipment
 1. Where portable equipment will be routinely connected and disconnected, provide clearly labeled, color-coded connectors to correspond with correct connection points.
 2. Provide Techflex cable umbilical wrap, or equivalent, where multiple cables are connected at the same plate or location. All exposed cabling is to be bundled for a neat and clean appearance.
 3. Provide finish samples and shop drawings to District for approval prior to ordering any AV Contractor-provided furniture or millwork.

- I. Millwork Coordination
 1. Verify final equipment and millwork clearances prior to ordering any audiovisual equipment. Notify the District in writing if any conflicts are identified.
 2. Coordinate and submit dimensional information of audiovisual equipment to be incorporated into furniture or millwork provided by other divisions to District and/or Architect for approval prior to any cutting or penetrations.
 3. Provide fans, ventilation slots/holes, or other hardware in millwork as required to conform to the manufacturers' operational temperature requirements.

- J. Grounding
 1. Use the equipment chassis as a common point of grounding the sound system; the equipment chassis is to be grounded to earth. Cable shields shall only be used for shielding (not signal) and connected to ground at the rack. All equipment shall be checked for ground continuity.

3.4 PROGRAMMING REQUIREMENTS

- A. Audio DSP
 1. Coordinate with District to provide contact closure from fire alarm system(s) to audio DSPs, mixers, processors, and/or amplifiers to mute all audio when fire alarm system is engaged. Test functionality in all locations and systems. Coordinate with local fire safety agency for verification and sign-off.
 2. Verify specified audio DSP will provide adequate processing power with manufacturer to accommodate functionality as described in this specification section prior to ordering.
 3. Provide required preset configurations to accommodate all routing conditions.
 4. Provide automatic microphone mixing and proper mix-minus routing systems where multiple installed microphones are utilized.
 5. All video source inputs are to include audio support, unless otherwise noted. All audio associated with video is to follow video source routing. Where identified, provide audio breakaway from video programming.
 6. Provide separate equalization and dynamic processing for speech and playback source inputs. Provide separate volume control(s) for speech and playback sources, including volume up/down and mute.
 7. Provide limiting on all drivers.
 8. Once a room has been properly equalized for a flat response, if microphone feedback issues occur during initial testing, provide dynamic feedback equalizer filters with fixed notches for microphone signals. Dynamically assigned feedback filters are to reduce filter depth and return to a flat state once feedback has been addressed.
 9. Ensure all playback source output within room is within 1.5 dB of one another when source output level is identical.
 10. Use available DSP processing algorithms as required to optimize audio performance in all spaces.

11. Audio and Video Conferencing Requirements:
 12. Provide Acoustic Echo Cancellation and Noise Reduction at individual microphones for any room utilizing audio or video conferencing system(s).
 13. Coordinate with District regarding audio routing to recording computers.
- B. Video Switchers, Processors, and Extenders
1. Video systems are to be configured to output the highest resolution available for the specified screen aspect ratio.
 2. EDID signals are to be managed throughout system. Where EDID management is not available, utilize EDID emulators.
 3. Where twisted-pair video transmitters and receivers are utilized, perform distance compensation adjustments as required to achieve an image that is equivalent to the original signal.
 4. Where possible, supply DC power remotely (via PoE or direct DC current) to video transmitters and receivers from equipment rack location(s) in an effort to avoid unnecessary power supplies within the room(s) served.
 5. Coordinate with District regarding which video source(s) shall be routed to the recording computer in each Classroom.
 6. Video switching shall be set-up and managed via virtual switching appliance hardware device. Training shall include dashboard set-up and training for appliance to allow District to make adjustments and troubleshoot encoder and decoder end-devices remotely.
- C. Control Systems
1. Coordinate with the District and Consultant regarding specific graphical control interface requirements. This includes individual system functional requirements, Control Panel graphic appearance, page hierarchy, and other control interface parameters. The control interface design should be uniform in look, feel, and functionality across all spaces and systems throughout the project, unless otherwise noted in this specification section or directed by the District.
 2. Coordinate with District regarding level of IP-based system status notification required for audiovisual system(s). This may include, but is not limited to equipment failure notification, power failure notification, temperature level notification, after hours system use notification, room use and scheduling requirements, and digital signage display status.
 3. All control system programming is to be provided by a programmer certified by the manufacturer of the control system to be provided.
 4. Provide software necessary to operate and program audiovisual system components. The software is to be provided by the manufacturer(s) of system components.
 5. One Button Studio Cameras shall route to Video Production Switcher over HDMI for camera inputs to be switched via video production switcher.
 6. Control Panels:
 - a. The AV Contractor is to submit Control Panel pages and layouts to the District and Consultant in an interactive format prior to implementation. This interactive format is to emulate functionality, page hierarchy, and other interactive design parameters.
 - b. Control Panel pages and language is to be easy to understand for non-technical users. Technical terms not commonly used outside of the audiovisual industry are to be avoided whenever possible.
 - c. Coordinate with District about which Control Panel functions shall be password protected.
 - d. Provide ample time for Control Panel review in order to address District-requested changes without negatively impacting the installation schedule. Provide, at no additional charge, reprogramming of control system components at District's request for a full (30) days after system acceptance.

- e. DSP Audio presets are to be recalled seamlessly in the background as a result of source selection and intuitive control options.
 - f. Coordinate with other divisions as required to incorporate control of other room systems within the Control Panel user interface, including, but not limited to:
 - 1) Mechanical/HVAC
 - 2) Lighting/Shades
 - 3) Electrical systems
 - g. At a minimum, all Control Panel user interfaces are to include the following control parameters:
 - 1) Master audiovisual system On/Off control, including prompt at shutdown asking user "Are You Sure?" with "Yes" and "No" buttons to prevent accidental shut down.
 - 2) In rooms where there is more than a single display, provide On/Off control for individual displays
 - 3) For rooms with video projectors, provide a message during power-up on Control Panel display indicating "The Projector is Powering Up. Please Wait..." until video projector is fully operational.
 - 4) For rooms with video projectors, provide a message during power-down on Control Panel display indicating "The Projector is Powering Down. Please Wait..." until video projector is fully shut down.
 - 5) Separate speech and playback volume controls
 - 6) Source selection is to be provided for individual displays, unless otherwise noted in this specification section
- D. Network Data Coordination
- 1. Coordinate with District regarding desired level of audiovisual network and other data network integration. If no interoperability is desired, the AV Contractor is to create an independent network for audiovisual equipment as required.
 - 2. Contractor shall set-up and deploy Crestron XiO Cloud services for remote deployment, management, and monitoring to all AV devices. This shall include, but is not limited to, AV device monitoring, equipment failure alerts, system use data, remote and scheduled power cycling, and any other function required by District. Coordinate with District for specific requirements.
- E. Classroom Type Rooms
- 1. Default routing –Classroom
 - a. Instructor computer content view routes to projector room and lectern confidence monitor
 - b. When laptop HDMI is plugged in, all projector switches to laptop input
 - 2. Control Panel Programming
 - 1) Refer to default routing above for default routing
 - 2) "VOLUME CONTROL" button
 - 3) "POWER ON/OFF" button
 - b. Sources
 - 1) "INSTRUCTOR COMPUTER" button
 - 2) "LECTERN HDMI" button
 - 3) "LECTERN USB-C" button
 - 4) "LECTERN DISPLAYPORT" button
 - 5) "DOC CAMERA" button
 - 6) "WIRELESS PRESENTATION" button
 - 7) "PROJECTOR ON/OFF" button shall allow user to turn on/off the selected display, where applicable.
 - c. When "AUDIO CONTROL" button is selected, Control Panel shall route to audio control page with volume sliders and mute buttons for each audio source.

- d. When "POWER OFF" button is selected, a prompt shall appear that asks, "ARE YOU SURE?" with "YES" and "NO" buttons.
- e. All Control Panel pages described above, with the exception of the startup page and power off page, shall include a main volume control slider and mute button.

3.5 PERFORMANCE SPECIFICATIONS

- A. Unless restricted by the published specifications of a particular piece of equipment which would prevent other devices from doing so, the following performance standards shall be met or exceeded:
 - 1. Audio Processing Equipment
 - a. Signal-to-Noise ratio (including crosstalk and hum): 75dB minimum
 - b. Total Harmonic Distortion (THD): 0.5% maximum from 20 Hz to 20 kHz
 - c. Frequency Response: Flat within 0.5 dB, 20 Hz to 20 kHz
 - 2. Video Processing and Routing Equipment
 - a. HDMI
 - 1) HDMI 2.0
 - 2) HDCP 2.2 Compliant
 - b. Analog Video
 - 1) Signal-to-Noise Ratio (peak to RMS), unweighted DC to 4.2 MHz: 45 dB minimum
 - 2) Crosstalk, unweighted DC to 4.2 MHz: 45 dB minimum
 - 3) Frequency Response (RGBHV): +/- 0.5 dB to 300 MHz
 - 4) Line and Field Tilt: 2% maximum
 - 5) Differential Gain: 3% maximum
 - 6) Differential Phase: 2 degrees maximum

3.6 VERIFICATION

- A. Make all adjustments and modifications necessary so that the system is operational and functions as intended herein.
- B. Make all adjustment and modifications necessary for proper system gain structure as detailed herein and per equipment manufacturers' instructions and recommendations. Mark settings of all variable controls to be preset using Avery Label self-adhesive "dots" or equivalent.
- C. Upon completion of the installation (prior to Acceptance Testing), the AV Contractor is to perform verification testing of all elements of the system as follows:
 - 1. General Performance Verification
 - a. All cable lines are to be tested for continuity, phase, shielding, proper labeling, and unreasonable signal loss.
 - b. All equipment is to be tested for proper operation.
 - 2. Video Performance Verification
 - a. Signal Level, Distortion, Hum and Noise
 - 1) For analog video signals, utilizing a NTSC video signal generator, vector scope, and waveform analyzer with the video signal set at 1 Volt P-P and 75% saturation, check that the video performance specifications as stated previously are met at all display devices from all source inputs.
 - 2) Utilizing a laptop PC with 1080P and WUXGA color graphics capability, check that the video performance specifications are met at the display devices from all applicable source inputs.
 - b. Level Balance
 - 1) Adjust all video equipment to produce the best image possible according to manufacturer's instructions. Ensure that horizontal sweep circuitry is

- not overdriven to the point of audible sweep frequencies are being emitted.
- 2) Adjust all video cameras, monitors and media players to produce the best image possible according to manufacturer's instructions.
 - 3) Adjust all video distribution amplifiers for unity gain of luminance and chrominance at the end devices.
3. Audio Performance Verification
- a. Upon completion of the systems testing, the AV Contractor is to adjust, and uniformly calibrate all gain adjustments of the audio systems and related system devices.

3.7 ACCEPTANCE TESTING

- A. After completing preliminary testing, the AV Contractor shall furnish District with a cover letter describing system performance, and a report documenting the results of the preliminary tests, along two (2) copies of "as-built" wiring diagrams of the entire system, including the connection numbers, and their locations. The receipt of this documentation will constitute the AV Contractor's acknowledgment that the installation is complete and conforms to this specification, and is ready to be reviewed and tested by the Consultant.
- B. Acceptance testing shall be performed by the Consultant with assistance from the AV Contractor after receipt of report described above. AV Contractor shall provide a capable technician familiar with the installed AV systems for (2) single eight-hour days.
1. AV Contractor shall coordinate all site, room, millwork, and equipment cabinet access with District as required to fully test and verify installation.
 2. The AV Contractor shall furnish a laptop with all manufacturer supplied configuration software necessary for communicating with the Audio DSP. A review of system settings may be required for either of the programmable units at the Consultant's request, and settings may be adjusted if necessary.
 3. AV Contractor shall furnish all tools, test equipment, source equipment (including audio and video sources), and materials required to make necessary repairs, corrections, and adjustments required.
 4. Further electrical and acoustical measurements may be performed at the discretion of the District. Such measurements may include sound pressure levels, uniformity of coverage, distortion, or other pertinent characteristics.
 5. The Control System interface programmer shall be available during final testing to address and respond to control system interface questions, preset recall configuration assumptions etc.
- C. If further adjustments or work are required after acceptance testing, continue work until the system is made acceptable and at no additional cost to the District.
1. If acceptance is delayed due to incomplete installation or programming, defects in or failure of equipment, or because the installation fails to meet the requirements of this specification, and additional site visits are required, AV Contractor shall retain the Consultant, at the Consultant's standard hourly rate, for any additional Consultant time and expenses required due to extension of the acceptance testing.

3.8 DOCUMENTATION

- A. Furnish all submittal documents as identified in Part 1 of this specification section.
- B. Furnish an Operations and Maintenance Manual prepared for the District's technical staff, in preferred District format(s) (i.e. USB flash drive, hard copies, etc.) containing the following sections:

1. Service Reference Cover Sheet: Provide a cover sheet with AV Contractor name, address, telephone number, and website information.
 2. System Operation Instructions: Step-by-step operating instructions for the basic day-to-day use of the system, including power activation, connection of source devices, adjustment of volume levels, selection of sources, etc. Include illustrations and references to individual equipment manuals as necessary.
 3. Equipment Manuals: Include copies of individual equipment operation manuals separated by tabbed dividers. Order manuals in nominal signal path order (i.e. sources first, amplifiers/loudspeakers last), followed by control system manuals, followed by miscellaneous manuals.
 4. Equipment List: List all system equipment by manufacturer and model.
 5. As-built Drawings: Provide "as built" functional diagrams. Hard-copies, if required, shall be in reduced 11"x17" foldouts in clear plastic binder sleeves. Fold and insert drawings so that drawing title is clearly visible at the front of the sleeve.
 6. Provide software programmable device configuration files to the District for the following:
 - a. Control Systems (Source code, including any interfaces and computer-based application files).
 - b. DSP Audio System (DSP system configuration files).
 - c. Store files on site in the system documentation binders as CD-ROMs in disk sleeves. Provide the files on (2) USB flash drives.
 7. Maintenance: Devices requiring routing maintenance (such as video projector filters or lamps) shall be listed along with procedures and schedules for maintenance of those items. If information from the manufacturer is inadequate or item is custom, provide the information necessary for proper maintenance. Include parts lists and schematics as available from the manufactures and for all custom items.
 8. Service and Warranty Information: Furnish a clear statement of the AV Contractor's guarantee for the system and contact information for on-call services. Include manufacturer's warranty statement for all equipment including actual expiration dates.
- C. Submit a draft copy of the Operations and Maintenance manual to the Consultant prior to acceptance testing.

3.9 TRAINING

- A. Training shall only occur after final acceptance by the Consultant, unless otherwise directed by the District. AV Contractor shall furnish a complete Operations and Maintenance Manual to each participant at the time of training.
- B. At a time designated by the District, furnish (8) hours of instruction to the District's designated personnel in the use and operation of the system. The instructor is to be fully knowledgeable and qualified in system operation. If required by District, training sessions shall be video recorded in a format designated by the District for archiving.
- C. Furnish one (1) technician to be present and assist the District at the first two (2) major uses of the system as directed by the District.

END OF SECTION

SECTION 28 0000 - GENERAL SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general administrative and procedural requirements for the Security Sections in Division 28 with the intent to supplement, not supersede, the requirements specified in Division 1.
- B. Project Description Overview:
 - 1. Refresh of existing B500 communications and security system
 - 2. Access Control and Video Surveillance System.
 - 3. The access control and Video Surveillance systems will be an extension of the campus system. Provide one additional video recording server to increase storage capacity in the B1900 building. This additional server will expand the campus system to accommodate all new cameras in B1500, B1800, the Amphitheater and B600
 - 4. This project to comply with the Security Master Plan dated May 4, 2018:
 - a. Contractor responsible for obtaining a copy of this from the Campus Public Safety Office.
 - 5. Provide system testing as detailed in Part 3.
- C. Related Sections:
 - 1. Section 07 84 00: Firestopping.
 - 2. Section 08 71 00: Door hardware.
 - 3. Section 26 00 00: All electrical specifications.
 - 4. Section 27 00 00: All telecom specifications.
 - 5. Section 28 05 13: Security System Cabling.
 - 6. Section 28 13 00: Access Control and Alarm Monitoring System.
 - 7. Section 28 23 00: Video Surveillance System.
- D. System Description:
 - 1. Addition to existing Lenel S2 access control system and video management software, see description above

1.2 REFERENCES

- A. Reference to codes and standards of technical societies, trade organizations and governmental agencies are for the latest edition published prior to submittal of the bid. Consider such codes or standards a part of this Specification.
- B. Codes: Perform Work in accordance with applicable requirements of the latest edition of governing codes, rules and regulations including but not limited to:
 - 1. National Electric Code (NEC), NFPA 70.
 - 2. California Code of Regulations (CCR) Title 24, California Building Standards Code Part 2, Basic Building Regulations and Part 3, California Electrical Code (CEC).
 - 3. Building Codes (IBC) - (UBC).
 - 4. Uniform Fire Code (UFC).
 - 5. National, State, Local and other binding building and fire codes.
 - 6. Local Authority Having Jurisdiction (AHJ).

- C. Standards: Perform Work and furnish materials and equipment in accordance with the latest editions of the following standards as applicable:
1. Underwriter's Laboratories (UL): Applicable listing and ratings:
 - a. UL 294: Access Control System Units.
 - b. UL 1076: Proprietary Burglar Alarm Units and Systems.
 2. National Fire Protection Association (NFPA):
 - a. NFPA 70 National Electric Code.
 - b. NFPA 101 Life Safety Code .
 - c. NFPA 730 Guide for Premises Security.
 - d. NFPA 731 Standard for the Installation of Electronic Premises Security Systems.
 3. Institute of Electrical and Electronic Engineers (IEEE).
 4. Telecommunications Industry Associations (TIA).
 5. Federal Communications Commission (FCC) – Part 15 and Part 68.
 6. International Organization for Standardization (ISO) – quality management systems.
 7. Campus security standards.
- D. For conflicts between contract documents and referenced codes or standards, comply with the more stringent.
- E. Definitions of Division 1: Apply to the Division 28 Security System Sections
- F. Additional Definitions: The following list of terms as used in this specification defined as follows:
1. **Contractor:** The term "Contractor" refers to the installation Contractor responsible for the furnishing and installation of all work indicated within this Specification.
 2. **Construction Manager:** The terms "Construction Manager" mean the Owner's appointed representative.
 3. **Furnish:** Used to mean purchase, supply, provide and deliver to the Project site, protect and provide interim storage and be ready for unloading, unpacking, assembly, installation, and similar operations in accordance with Manufacturer's Specifications.
 4. **Provide:** Furnish and install, complete and ready for the intended use.
 5. **Install:** Describes operations at project site including the actual unloading, unpacking, rigging in place, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
 6. **Installer:** Contractor, Subcontractor or supplier using their own employees for construction activity related to their specified responsibilities. Installers are required to be an authorized Manufacturer's representative, experienced and qualified to provide, install, program, troubleshoot, train, warrant and service the systems in this section.
 7. **If Applicable:** That work required for construction completion at applicable locations, but is not necessarily shown or described in the Contract Documents.
 8. **As Necessary:** Work required for construction completion, but is not necessarily shown or described in the Contract Documents.
 9. **As Required:** Work required for construction completion, and is shown on the drawings or described in the project Specification.
 10. **Product:** The term "product" will mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
 11. **Governmental:** The term "governmental" means all municipal, state and federal government agencies.
 12. **UL/NRTL Listed:** Indicates that a product is listed to the applicable standard for which it will be used; the standard is typically written by UL or ANSI; the product testing can be done by any Nationally Recognized Testing Laboratory, such as UL or ETL.
 13. **Words in the singular:** will also mean and include the plural, wherever the context so indicates, and words in the plural will mean the singular, wherever the context so indicates.

- G. Abbreviations and Acronyms:
1. ACAMS: Access Control and Alarm Monitoring System.
 2. AHJ: Authority Having Jurisdiction.
 3. AoR: Area of Refuge.
 4. DGP: Data Gathering Panel (access control field panel).
 5. DMA: Door Management Alarm (door prop alarm annunciator).
 6. ECS: Emergency Communication System.
 7. FOV: Field of View.
 8. FPT: Functional Performance Test.
 9. IDS: Intrusion Detection System.
 10. IP: Internet Protocol.
 11. IT: Information Technology.
 12. MAC: Medium Access Control (Ethernet layer 2, used for device address).
 13. NICET: National Institute for Certification in Engineering Technologies (levels I to IV).
 14. NRTL: Nationally Recognized Testing Laboratory.
 15. OBVA: Object Based Video Analytics.
 16. OSDP: Open Supervised Device Protocol – access control standard.
 17. PDF: Portable Document Format by Adobe.
 18. PoE: Power over Ethernet.
 19. SOT: System Operational Test.
 20. TIA: Telecommunications Industry Association.
 21. TCP/IP: Transmission Control Protocol/Internet Protocol.
 22. UL: Underwriters Laboratory (standards writing and testing organization).
 23. UPS: Uninterruptable Power Supply.
 24. VSS: Video Surveillance System.

1.3 PRICING

- A. Provide add and deduct pricing for all specified components.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Provide a project manager/engineer:
1. For the duration of the project to coordinate the security system Work with other trades.
 2. Coordination services, procedures and documentation responsibility include at a minimum, the items listed in this section.
 3. Obtain copies of shop drawings for equipment provided by others that require security connections or interface with the security system Work.
- B. Request for Information (RFI):
1. Thoroughly review the contract documents prior to submitting an RFI, including drawings and specifications:
 - a. Attach 8 1/2" x 11" copies of relevant documents to clarify the issue.
 2. Submit RFI's according to the General Contractor's procedure.
- C. Weekly Status Reports:
1. Prepare weekly status reports throughout the entire course of the project containing the following information:
 - a. Progress during prior week.
 - b. Work completion expected during the upcoming week.
 - c. Delivery dates for equipment.
 - d. Status for each device requiring coordination with other subcontractors.
 - e. Summary of the information owed to the Contractor, who is responsible for providing the information, and due date for the information.

- D. Role of the Engineer:
 - 1. Provide interpretation and clarification of project contract documents.
 - 2. Process and reply to relevant Requests for Information (RFI).
 - 3. Act as an interface between the Contractor and the Owner.
 - 4. Observe the Work for general compliance with the Contract Documents.

- E. Permits and Inspections:
 - 1. Obtain and pay for permits and inspections required for the Work.
 - 2. Furnish materials and workmanship for this Work in conformance with applicable legal and code requirements.
 - 3. Perform tests to demonstrate conformance with the Specifications.
 - 4. Obtain review from compliance officials responsible for enforcement of applicable codes and regulations.

1.5 CONTRACTOR QUALIFICATIONS

- A. A current, active, and valid C7 or C10 California State Contractors License.
- B. Contractor must be a certified dealer for the products specified.
- C. Minimum of 5 years' experience in the installation and service of the specified systems.
- D. Minimum five completed projects similar to scope and cost.
- E. The project manager and lead technicians shall have a minimum 5 years of engagement in projects with similar scope and systems.
- F. Evidence of lead technicians' qualification for the project in the form of current manufacturer training certification for every system specified.
- G. Contractor must maintain a service office within a 50-mile radius of the project to provide warranty service.

1.6 SUBMITTALS

- A. General:
 - 1. Provide submittals according to the Division 01 Submittal Procedures Section as well as the following minimum requirements

- B. Submit with Bid:
 - 1. Project Manager and Lead Technician(s) Resumes:
 - a. Indicate project role, years of experience, product certifications and training.
 - b. List similar projects the individual performed the role proposed for this project.
 - 2. Contractor Certification:
 - a. Provide manufacturer certification letters of major system components.
 - b. Provide certification letters of lead Technician.
 - c. State License Type and Number.

- C. Product Data
 - 1. Provide submittal electronically using Portable Document Format (PDF).
 - 2. Each specification section shall be in a separate file with:
 - a. Cover sheet describing the section, contractor name, project name and date of submission.
 - b. Table of contents:

- 1) Order products in the file in the same order as listed in the specification.
 - c. List all products used in a section, even if the same produce is duplicated in other sections.
 3. Products with battery backup power:
 - a. Provide calculations that show standby power capacity complies with the specification.
 - b. List the load power.
 - c. List the number of batteries, or battery packs along with their capacity.
 4. Video storage devices:
 - a. Provide manufacturer calculations showing the storage capacity using the submitted cameras, with the specified resolution and recording rates.
 5. Resubmittals:
 - a. Resend the entire submittal with the updated product information.
 - b. Update the table of contents to indicate the products that have changed.
 - c. Add the resubmittal date to the submittal cover page.
 - D. Shop Drawings:
 1. Prepare shop drawings from GC provided CAD drawing.
 - a. Include field labeling for cables, panel, ports, and devices.
 - b. Point-to-Point wiring diagrams for field panels, devices, power supplies, and relays.
 2. Optional use of Engineer's AutoCAD/Revit files:
 - a. Engineer will provide AutoCAD/Revit files, upon receipt of signed shared file release agreement.
 3. Submit the shop drawings for review and approval prior to the installation of equipment.
 - E. Security System Labels
 1. Submit labeling scheme in word document for each field device prior to permanent labeling for review and approval by engineer.
 - F. Contractor Qualifications:
 1. Project Manager and Lead Technician(s) Resumes:
 - a. Indicate project role, years of experience, product certifications and training.
 - b. List similar projects the individual performed the role proposed for this project.
 2. Contractor certification:
 - a. Provide manufacturer certification letters of major system components.
 - b. State license type and number.
 - G. Training Materials:
 1. See Training below.
- 1.7 CLOSEOUT SUBMITTALS
- A. As-Built Drawings:
 1. Drawings shall be in current AutoCAD or Revit format using the same version as the architect.
 2. The drawings shall reflect all of the changes made throughout the project, including addenda, RFI responses, change orders, and changes due to site conditions.
 3. Use commonly recognized drafting techniques that follow the standards of AutoCAD/Revit.
 4. Follow the drafting standards, formats and guidelines of the architect showing:
 - a. All security devices, field panels, racks and computers.
 - b. Symbol legend.
 - c. Cable routing.
 - d. Cable labeling.

5. Provide elevation drawings showing device installation details.
 6. Provide block riser diagram showing device and subsystem interconnections.
 7. Provide one set of full-size sheets (actual size specified by architect).
 8. Provide an electronic copy of the drawings in AutoCAD/Revit and PDF formats:
 - a. Provide files electronically. Place the files within a folder labeled with the project name, contractor name and date.
 9. Submit the hard and soft copies of the project documentation within 30 days of completion.
- B. Operation and Maintenance Manuals (O&M Manuals)- for each system provide:
1. Provide the Owner with 2 hard copies of system manuals, and 1 electronic copy in PDF.
 2. Hard copy manuals shall be in adequately sized three-ring binders, clearly labeled on the spine.
 3. Provide a PDF copy for the Design Engineer.
 4. O&M Manuals shall contain the following:
 - a. Cover sheet with Security Contractor name, address, telephone number and web address.
 - b. Table of contents: listing each manual and drawing.
 - c. System Operation Instructions:
 - 1) Step-by-step operating instructions for the basic day-to-day use of the system including system startup, and system shutdown.
 - 2) Include illustrations and references to individual equipment manuals as necessary.
 - d. Equipment Manuals: include copies of individual equipment operation manuals
 - e. Equipment List: list all system equipment including, field/control panels, card readers, cameras, workstations, monitors, storage devices, intercoms, intrusion alarm devices and duress alarms.
 - f. As-built Drawings:
 - g. Provide software programmable device configuration files for all systems.
 - h. The FPT test documents in hard copy and PDF.
- C. Software
1. Provide all necessary software, installation codes, serial numbers, installation instructions, and documentation so that a technician trained and certified by the equipment manufacturer and authorized by the Owner, can reinstall and modify the software.
- D. Provide all warranty documentation.
- E. Provide all maintenance contract documentation.
- 1.8 QUALITY ASSURANCE
- A. General:
1. Provide new and unused materials, equipment, and parts.
 2. Only use products and applications listed in the associated security Sections on the project.
- B. Substitutions:
1. Substituted products must be of equivalent design, construction, and performance.
 2. Include substituted product cut sheet in product data submittal and stamp or mark clearly at top of page "SUBSTITUTE".
 3. Ensure that the entire system operates as specified with substitution.

1.9 CYBER SECURITY

- A. Maintenance contract to include a Software Support Agreement (SSA) from the Security System manufacturers requiring periodic software updates and patches that address known vulnerabilities.
- B. Update all Security Systems software and firmware to the most current version.
- C. Passwords:
 - 1. Coordinate with the Owner on the password strategy.
 - 2. For each system, provide passwords for all administrative levels that will enable the trained and certified representative to make all administrative and configuration changes.
 - 3. All factory passwords are to be changed.
 - 4. Each device shall have a unique password:
 - 5. Treat all passwords as confidential and security sensitive:
 - a. Provide the passwords directly to the Owner's designated System Administrator.
 - b. Provide a transmittal to the GC indicating the date and the name of the person receiving the passwords.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Storage:
 - 1. Store materials in a secure, clean, dry, ventilated space free from temperature extremes.
 - 2. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
 - 3. Provide heat where required to prevent condensation or temperature related damage.
 - 4. Do not accept delivery of materials until the above storage is available.
- B. Handling:
 - 1. Handle in accordance with manufacturer's written instructions.
 - 2. Prevent internal component damage, breakage, denting and scoring.
 - 3. Do not install damaged equipment.
 - 4. Replace damaged equipment and return equipment to manufacturer.

1.11 WARRANTY

- A. Provide a 1-year parts and labor service warranty according to the Conditions of the Contract, and Division 01:
 - 1. Use the more stringent warranty requirements if there is a conflict with Division 01.
 - 2. Warrant all installed Work and components to be free from defects in design and workmanship.
 - 3. Warranty shall start on final acceptance of system by the Owner including:
 - a. Successful completion of all functional performance testing.
 - b. Completion of all punch list items.
- B. Provide 24-hours per day, 7-days per week service response:
 - 1. Provide telephone technical support response requests within 2 hours.
 - 2. Provide technical repair personnel onsite within 4 hours of service request.
 - 3. If repairs are not complete within 8 hours of the service request, the Owner reserves the right to escalate to a higher level of service support.
 - 4. If the system is not operational with at least loaner components, within 12 hours of the service request, the Owner reserves the right to require:

- a. Continuous 24-by-7 on-site work effort by qualified technical staff until the system is operational.
- b. Provide a written action-plan, signed by the highest level of local management, describing the course of action and the service escalation plan.
5. Complete repairs within 48 hours after service request:
 - a. The Owner reserves the right to require on-site manufacturer support if the repairs exceed 48 hours.
- C. Provide qualified technical repair personnel familiar with the Work on this project:
 1. Perform service work using factory certified technicians.
 2. Provide a loaner component to make the system operational, if a component is not repairable in the field.
 3. Provide the Owner a report for every service call detailing:
 - a. Work completed.
 - b. Cause of failure.
 - c. Outstanding issues.
 - d. Time and date of request and completion of repair.
 4. Conduct warranty repairs at the job site. If an on-site repair violates manufacturer's warranty, provide:
 - a. Substitute systems or equipment, acceptable to the Owner, for the duration of off-site repairs.
 - b. Provide substitutions and labor under the warranty.
- D. Transfer extended manufacturer warranties to the Owner.

1.12 TRAINING

- A. Provide user training for the Owner's designated staff:
 1. Coordinate with Owner on training class content to accommodate the Owner's operational requirements:
 - a. Schedule coordination meeting fourteen (14) business days in advance of first training class.
 2. Provide 6 hours of system operation training:
 - a. Content to include:
 - 1) Step-by-step operating instructions for day-to-day use of the system.
 - 2) High-level system architecture and sub-system integration as it affects system operation.
 - 3) System startup and shutdown.
 - 4) Include illustrations and references to individual equipment manuals as necessary.
 3. Provide 8 hours of system administration training session up to 4 people:
 - a. Content to include:
 - 1) High-level system architecture and sub-system integration as it affects system operation and administration.
 - 2) All system administration commands for each subsystem.
 - 3) Discuss system operation best practices in conjunction with the Owner's operational requirements.
 4. Coordinate with the Owner on scheduling the classes. The Owner reserves the right to schedule classes that accommodate their operational requirements.
- B. Provide Training Manuals:
 1. Provide one hardcopy, bound manual for each student and two spare copies.
 2. Provide the Manuals electronically in PDF.
 3. Training Manuals Shall Include:

- a. Title page, with Manual subject material, date, Owner's name and Owner approved confidentiality notice.
 - b. Table-of-contents.
 - c. Support phone number.
 - d. Support call in procedure.
 - e. Contents to support the above training sessions.
4. Submit training manuals for approval seven (7) days prior to training classes.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The material and equipment specified are the minimum acceptable quality and performance:
 1. They are to function as components of the overall integrated system.
- B. Provide materials permanently labeled with the manufacturer's name, model and serial number.
- C. Use standard, regularly manufactured, materials, software, and equipment:
 1. Do not provide custom designed products for this project.
 2. Provide systems and components thoroughly tested and proven in actual use.
 3. Provide subsystems of one manufacturer.

2.2 SURGE PROTECTIVE DEVICES (SPD):

- A. Provide self-restoring SPDs.
- B. Data/signal line SPDs:
 1. Utilize silicon avalanche diode and MOV components.
 2. Provide SPD with verified transmission rate, without signal attenuation, and is compatible with protected device data requirements.
 3. Provide SPDs with manufacturer recommended clamp voltage for the protected device.
 4. NRTL listed to UL 497A for telephone lines.
 5. NRTL listed to UL 497B for data and signal line circuits.
- C. Power line SPD:
 1. Suppression between L-N, L-G, N-G.
 2. Maximum continuous operating voltage 125 VAC.
 3. Status indicator light(s).
 4. NRTL listed to UL 1449.
- D. Manufacturers:
 1. DITEK.
 2. Edco.
 3. ITW Linx.

2.3 TAMPER RESISTANT HARDWARE

- A. Provide Torx Pin-Head tamper resistant screws to secure hardware in public spaces:
 1. Provide screws with corrosion resistance.
 2. Match finish color for screws used in specialty metal surfaces.
 3. Provide 4 screwdrivers for removal of tamper resistant screws.

2.4 LABELS

- A. Manufacturer:
 - 1. Brady
 - 2. Thomas and Betts

- B. Wire and Cable Labels:
 - 1. Self-laminating adhesive laser labels.
 - 2. Machine printable with a laser printer.
 - 3. Color: white with black lettering
 - 4. Manufacturer:
 - a. Brady wire marking labels WML-211-295 and WML-311-292
 - b. Write-on labels are unacceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Conditions: Verify existing conditions are acceptable for product installation in accordance with manufacturer's instructions.

- B. Pathways: Verify proper installation of pathways and supporting devices:
 - 1. Remove temporary supports and devices.

- C. Field Measurements: Verify dimensions prior to installation.

3.2 FIELD QUALITY CONTROL

- A. Staffing:
 - 1. Provide a qualified supervisor who is in charge of the Work and who is present at the job site at times Work is being performed.
 - 2. Perform the Work using skilled technicians under the direction of the supervisor.
 - 3. Supervise the work force executing the Work.
 - 4. Perform the installation within the restraints of the construction schedule.
 - 5. Do not change the supervisor during the project without prior written approval from the Owner.

- B. Inspection:
 - 1. Perform inspection after installation.
 - 2. Keep areas of work accessible and notify code authorities, or designated inspectors, of work completion released for inspection.
 - 3. Document completion and inspection as required.

3.3 INSTALLATION

- A. Perform this work in accordance with acknowledged industry and professional standards and practices.

- B. Provide a complete, operating system. Include:
 - 1. Specified devices, components, accessories, and interconnecting wiring for a complete system.

- C. Coordinate commercial and emergency power requirements with Division 26 and Division 27 contractors.
- D. Manufacturer's Instructions:
 - 1. Install all equipment per manufacturer's recommendation.
- E. IT coordination:
 - 1. Coordinate with the Owners IT staff on IP assignments, and cyber security requirements.
- F. Surge Protective Devices (SPD):
 - 1. Install SPDs to protect:
 - a. The 120 VAC line power to the security equipment.
 - b. The ACAMS, and VSS devices located outside of a building connected via metallic signal and/or power lines.
 - 2. When security devices are connected to exterior metallic conductors, including underground metallic conductors, install SPDs at both ends of the conductor.
 - 3. Match SPD equipment to the protected equipment, including wire sizes, operating voltages, currents and number of conductors.
 - 4. Install SPDs with hardwired low-voltage circuit lead lengths (conductor/wire distance) a minimum of 3 wire feet, (unless otherwise specified by manufacturer) and that the referenced ground connections are of a lesser distance (conductor/wire length).
 - 5. All required surge protection must be installed, according to manufacturer instructions, prior to applying power or connecting signaling conductors to electronic components.
- G. Labeling:
 - 1. Wire and Cable
 - a. Identify wire and cable clearly with permanent machine-generated labels:
 - 1) Attach labels to cable jacket.
 - 2) Do not label individual conductors.
 - b. Show cable ID on the associated field or shop drawings.
 - c. Positional labels so they are clearly visible without the need to remove wire management or other obstructions.
 - d. Label cables at both the control equipment and the device location.
 - 2. Cable Label Format
 - a. Contact engineer for labeling format prior to labeling.
 - b. Remove labels with unapproved format.
- H. Conduits Boxes, Panels, and Enclosures:
 - 1. Identify conduits and boxes with a unique paint color.
 - 2. Do not write on boxes or conduit identifying them as security system infrastructure.
- I. Finishes:
 - 1. Coordinate with the architect color and finishes with all devices and equipment in public areas.
- J. Provide as-built drawings.
- K. Coordinate with Owner on passwords for systems:
 - 1. Replace all default passwords.
- L. Provide backup copy of all software.

3.4 REPAIR/RESTORATION

- A. Replace or repair damaged work.
- B. Repaint surfaces altered during installation of the security system to match previous conditions.

3.5 CLEANING

- A. Remove temporary coverings and protection of adjacent work areas. Remove unused products, debris, spills, or other excess materials. Remove installation equipment.
- B. Leave finished work and adjacent surfaces in neat, clean condition with no evidence of damage.
- C. Repair or replace damaged installed products.
- D. Legally dispose of debris.
- E. Clean installed products in accordance with manufacturer's instructions.

3.6 TESTING

- A. Perform testing below to demonstrate system operation, performance and workmanship:
 - 1. Submit test plan and test documents 10 business days prior to scheduled testing:
 - a. Testing shall not begin without an Owner approved test plan.
 - b. Design test plan to minimize impact on Owner ongoing operations.
 - 2. The Owner or the Owner representative will witness testing.
 - 3. Malfunction or defective equipment shall be replaced or repaired, then retested until all equipment in the system is fully operational.
 - 4. Provide sufficient staff and communication equipment to perform testing without relying on the Owner's staff or communications equipment.
 - 5. The cost for retesting due to high failure rate or noncompliance with contract documents may be borne exclusively by the contractor at the Owner's representative's discretion.
 - 6. Upon the successful completion of each test, the test documents shall be signed by the contractor and Owner witnesses, scanned and submitted as part of the final system documentation package.
- B. Functional Performance Test (FPT):
 - 1. Prior to the FPT, the system must be pretested:
 - a. All devices must be tested.
 - b. All subsystem integration must be tested.
 - c. All deficiencies must be corrected prior to the start of the FPT.
 - 2. Testing shall be comprehensive:
 - a. All equipment and software functions shall be tested for every device, field panel, network device, computer and auxiliary equipment.
 - b. Subsystem integration shall be tested such as camera call-up.
 - c. Mechanical operations of the doors must be tested to ensure that doors with electronic security properly close and latch – report mechanical door problems to the general contractor.
 - d. Cameras are checked for proper field of view and are in focus.
 - e. An image of all cameras will be recorded in the test documents.

- f. Review the video recorder settings ensuring that they are within contract specifications.
 - g. Review the video recorder storage to ensure that the recorder will meet contract specification storage requirements.
 - h. Review network switch settings for all switches, provided by the security contractor, to ensure that they are within contract specifications for performance and IT security.
 - i. Review the ACAMS server and software to ensure they meet contract specifications.
 - j. Review the IDS to ensure the system meets contract specifications.
3. The FPT may be terminated at any time due to a high failure rate or noncompliance with the contract documents at the discretion of the Owner's representative:
- C. System Operational Test (SOT):
1. Upon completion of the FPT and prior system acceptance, demonstrate that the system operates in a stable and reliable fashion.
 2. Perform this test over a 72-hour period.
 3. The test shall be in the operational environment with all subsystems, field panels and devices operational.
 4. The entire system shall operate error free for the duration of the test.
 5. If there are faults, document and repair them before restarting the test from the beginning of the test period.

END OF SECTION 28 00 00

SECTION 28 0513 - SECURITY SYSTEM CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working security system installation, as described in these specifications.
- B. Section Includes:
 - 1. Wire and cable.
- C. Related Sections:
 - 1. Consult other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
 - 2. Section 28 00 00 Basic Security Requirements: includes general project requirements, submittal formats, installation, and warranty requirements.
 - 3. Section 26 05 33 Conduit: includes pathway types in different areas of the project.

1.2 SUBMITTALS

- A. Product Data: Submit product information, including:
 - 1. Cable Description and Use.
 - 2. Jacket Rating.
 - 3. Outside Diameter (of the overall wire or cable).
 - 4. Manufacturer.
 - 5. Part Number.

1.3 MAINTENANCE MATERIAL

- A. Spare Parts:
 - 1. Refer to Section 28 00 00 for spare part requirements.
 - 2. Provide 2 (unless otherwise specified) of the following patch cables:
 - a. Wet Environment patch cables of each size provided.
 - b. Interior camera, patch cables.
 - c. Security patch panel, patch cables.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

- A. General:
 - 1. Provide required wire and cable sized to allow for voltage drop on long runs and effectively shielded as required to allow the routing of 12 & 24V power and video signal cable in the same conduit without interference or signal noise.
 - 2. Provide U.L. approved cable for its intended application and meet manufacturer's recommendations for the components connected.
 - 3. Comply with NEC, and local building code, cable requirements for each cable's application.

- a. All UTP cable will be provided by Division 27 contractor.
- B. Access Control & Alarm Monitoring System cable:
 - 1. Provide cable and wire recommended by manufacturer, and as required by the current NEC, and local building code.
 - 2. Provide cable and wire sized to accommodate the conductor voltage drop, device current draw, and distances for the cable runs.
- C. Video Surveillance System cable:
 - 1. Provide cable and wire recommended by manufacturer, and as required by the current NEC, and local building code.
 - 2. Provide cable and wire sized to accommodate the conductor voltage drop, device current draw, and distances for the cable runs.
 - 3. For UTP structured cabling, refer to Section 27 00 00 for cable and installation requirements.
 - 4. Data drops by Division 27.
- D. Patch Cables:
 - 1. Provide pre-manufactured patch cables to connect security systems to data communication jacks.
 - 2. Provide patch cables certified for their specific use, and meet applicable industry standards.
 - 3. Provide cable lengths as necessary to neatly route cables through cable management systems and other cable organization systems.
 - 4. Provide connectors as required for proper termination.
 - 5. Provide boots for connectors to prevent snagging.
 - 6. Coordinate with Owner's IT representative on cable color requirements.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to Section 28 00 00 General Security Requirements.
- B. See Section 28 00 00 for Security System Label requirements.
- C. Coordinate installation activities with the following Divisions or groups:
 - 1. Division 8 – Door hardware, doors, and frames.
 - 2. Division 14 - Elevators
 - 3. Division 26 – Electrical power and pathways.
 - 4. Division 27 – Telecom voice and data cabling.
 - 5. Authority Having Jurisdiction for life-safety requirements.
 - 6. Fire alarm contractor.
 - 7. CLPCCD IT group.

3.2 EXAMINATION

- A. Conditions: Verify existing conditions are acceptable for product installation in accordance with manufacturer's instructions.
- B. Pathways: Verify proper installation of pathways and supporting devices:
 - 1. Remove temporary supports and devices.

C. Field Measurements: Verify dimensions prior to installation.

3.3 INSTALLATION

A. Label cables in accordance with Section 28 00 00

B. Horizontal Cable Installation and Routing:

1. Provide continuous and splice-free wire or cable for the entire length of the run from origination to termination.
2. Contractor will provide separate pathways for security cabling within the structured cabling system, such as cable tray, basketway, cable hangers, etc.:
 - a. Do not fasten or attach cables to other building infrastructure (such as ducts, pipes, conduits, ceiling support wires, wall studs, etc.), or other non-approved pathway systems.
3. Place and suspend cables and conductors during installation and termination in a manner to protect them from physical interference or damage.
4. Place cables with no kinks, twists, or impact damage to the sheath:
 - a. Replace cables damaged during installation or termination at no additional cost.
5. Route cables at 90-degree angles, allowing for bending radius, along corridors for ease of access.
6. Do not exceed manufacturer's limits for pulling tension.
7. Do not use cable-pulling compounds for indoor installations.
8. Route cables under building infrastructure (such as ducts, pipes, conduits, etc.) so the installation results in easy accessibility to the cables in the future. Do not route cables over building infrastructure.
9. Dress and secure cables to preclude stress and/or deformation.
10. Install shielded wiring or route in separate raceways as recommended by the manufacturer.
11. Place cables 6", minimum, away from power sources to reduce interference from EMI
12. Do not run signal wire and cable in parallel to power (120VAC).
13. Make connections to screw-type barrier blocks with insulated crimp-type spade lugs. Size lugs properly to assure high electrical integrity, i.e., low resistance connections.
14. Follow manufacturers recommended guidelines for installation.

C. Vertical Cable Installation and Routing:

1. Secure wire and cable run vertically in conduit for continuous distances greater than thirty (30) feet at the vertical run terminations.
2. Secure non-UTP cables using screw-flange nylon cable ties or similar approved devices, Thomas and Betts or equivalent.

D. Ground the cable shields as recommended by the hardware manufacturer:

1. Ground cable shields at the field panel feeding the device or sub panel and insulated from ground at the termination end of the cable.

3.4 CABLE SUPPORT

A. Horizontal Support:

1. Concrete and Metal Construction (Above Ceiling):
 - a. Provide separate and dedicated cable support system for security cable runs.
 - b. Anchor cable support system to structural ceiling.
 - c. Support and tie cables at a maximum of 5-foot intervals.
2. Wood Construction (above ceiling and no ceiling):
 - a. Support cable utilizing appropriately sized drive rings or "D" rings.
 - b. Fasten rings to structural ceiling.
 - c. Install drive rings at approximately 5-foot intervals.

- d. Route cable through drive rings and cable tie at 10-foot intervals, or every other drive.
- 3. Vertical cable on floor space not in riser system:
 - a. Route cable from below suspended ceiling devices to above ceiling when possible.
 - 1) Provide conduit and firestopping for cable routed in fire rated wall assemblies.
 - 2) Provide conduit for cable routed from below ceiling devices to above ceiling on concrete tilt up style walls.
 - b. Cable routed vertically from devices with no suspended ceiling:
 - 1) Provide conduit stub from device junction box to 14 feet A.F.F minimum.

END OF SECTION 28 0513

SECTION 28 1300 - ACCESS CONTROL AND ALARM MONITORING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. General: Furnish engineering, labor, materials, tools, equipment, programming, and transportation as required to make a complete working Access Control and Alarm Monitoring System (ACAMS) as described in the contract documents.
- B. Section includes:
 - 1. Access control field panels, and card readers.
 - 2. Door contacts and request to exit devices.
 - 3. Emergency door release devices.
 - 4. Interface to electric door hardware.
 - 5. Integration and connections between security subsystems.
 - 6. Lock power supplies.
 - 7. Device power supplies.
 - 8. Uninterruptable power supplies.
- C. Products furnished but not installed under this section:
 - 1. None.
- D. Related Sections:
 - 1. Section 07 8 400: Firestopping.
 - 2. Section 08 71 00: Door Hardware.
 - 3. Section 26 00 00: Electrical.
 - 4. Section 27 00 00: Communications.
 - 5. Section 28 00 00: General Security Requirements.
 - 6. Section 28 05 13: Security System Cabling.
 - 7. Section 28 23 00: Video Surveillance System.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. See Section 28 00 00.
- B. Definitions:
 - 1. See Section 28 00 00.

1.3 SYSTEM DESCRIPTION

- A. Overview:
 - 1. The ACAMS consists of the field panels, card readers, locks, door operators, outputs, and alarm initiating devices.
 - 2. The ACAMS will be based on the Lenel S2 system (LPC Campus Standard)
 - 3. The ACAMS components communicate to the existing server and workstations over the Owner's LAN.
 - 4. Integrate the ACAMS to the Video Surveillance System (Section 28 23 00).
 - 5. Provide all labor, equipment, tools, services, and software (excluding specified products provided by others) required to make the ACAMS fully operational and complete.

- B. Access Control and Alarm Monitoring System:
 - 1. This project is an extension of the Owner's existing ACAMS (Lenel S2).

- C. OSDP compliance:
 - 1. The card readers and DGP communication to the card readers must be compliant with the open standard, developed by the Security Industry Association (SIA), the Open Supervised Device Protocol (OSDP) latest version unless otherwise noted.

- D. ACAMS commissioning:
 - 1. Provide database to support a fully operational ACAMS.
 - 2. Coordinate meetings with Owner's physical security representative to develop ACAMS database and graphical UI content.
 - 3. Obtain Owner approval of database content prior to loading database.

- E. Coordinate with Fire Alarm Contractor.
 - 1. Interface ACAMS to Fire Alarm for compliance with life safety code requirements.
 - 2. Connect ACAMS to Fire Alarm relay(s).

- F. Alarm Notification:
 - 1. Provide an Owner configurable, priority driven, alarm notification capability for ACAMS alarms.
 - 2. Graphical Maps:
 - a. Provide a graphical representation of the alarm type and its location.
 - b. Provide controls on the maps to control locks and door/gate operators.
 - c. Provide controls to call-up video cameras in the area.
 - d. Provide map navigation so operator can intuitively select from the overall site display down to the individual map showing alarms and controls for the area of interest.
 - e. Coordinate with Owner on map navigation simplicity and the amount of detail in each map.

- G. Fault Monitoring:
 - 1. Provide alarm notification of conditions that affect the health of the ACAMS.
 - 2. Log ACAMS alarms in the system transaction log.
 - 3. Data Gathering Panels (DGP):
 - a. Input wire faults.
 - b. AC power loss.
 - c. Battery fault.
 - d. Communication fault.
 - 4. UPS faults:
 - a. AC power loss.
 - b. Low battery.
 - c. Battery charging fault.

- H. Tamper Monitoring:
 - 1. Provide tamper switches for:
 - a. DGP, security system equipment, and termination enclosures.
 - b. Power supply, power distribution, and battery enclosures.
 - c. Equipment enclosures.
 - 2. Fasten tamper switches to prevent access to the switch from the enclosure exterior.
 - 3. Provide individual inputs for each enclosure's tamper switches.

- I. Card Readers:
 - 1. All card readers shall be HID Global Signo series readers

- J. Request-To-Exit (REX):
 - 1. Provide PIR Request to Exit sensors for doors using door strikes:
 - a. Install and configure detector detection pattern to mitigate spoof attacks from objects slid under the door threshold.
 - b. Connect REX sensor output to DGP REX input.
 - 2. Connect REX switch in door lock to DGP REX input.

1.4 DOOR HOLD OPEN DEVICES

- A. The Door hold open devices are specialized door closers provided and installed by Division 8 and controlled by the ACAMS and Fire alarm System.
- B. Stairwell doors may be used for communicating between the floors by the public on an ACAMS schedule.
 - 1. When the schedule is active the associated card reader will activate, energizing the hold open devices in the door closer.
 - 2. When hold open is energized the door can be manually opened and will remain open until the schedule deactivates, or the fire alarm activates.
 - 3. When the schedule is active, and output connected to the associated Door Management Alarm (DMA) will bypass the alarm.
 - 4. When the schedule deactivates, the hold open will deenergize causing the door to close, 30 seconds later, the DMA bypass will deactivate, providing time for the door to close.
 - 5. When the schedule is deactivated staff can use the stairwells without triggering the DMA by using their card in the card reader.
 - a. Note: the card reader only bypasses the DMA, it does not control the door lock, free egress is always available.
 - b. A REX switch in the stairwell side trim will bypass the DMA when on exiting the stairwell door.
- C. The Hold Opens are 24VDC and will be powered from the lock power supply.
 - 1. The fire alarm output relay, connected to the power supply, will deactivate the Hold Open power.

1.5 CYBER SECURITY

- 1. See Section 28 00 00.

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate with Division 26 on electrical infrastructure requirements.
 - 2. Coordinate with Division 27 on telecom cabling and infrastructure requirements.
 - 3. Coordinate with AHJ on life-safety requirements.
 - 4. Coordinate with Owner's physical security representative include:
 - a. Alarm notification content.
 - b. Graphic map display content.
 - c. Access control credential requirements.
 - d. User access rights to the ACAMS.
 - e. Subsystem integration requirements.
 - f. System operator, support personnel, and administrator training.
 - g. Existing equipment integration.
 - h. With Owner to minimize disruption to ongoing security operation caused by project work.

1.7 SUBMITTALS

- A. Provide submittals according to Section 28 00 00 General Security Requirements.

1.8 QUALITY ASSURANCE

- A. See Section 28 00 00.

1.9 DELIVERY, STORAGE, AND HANDLING

1.10 SEE SECTION 28 00 00.

1.11 SITE CONDITIONS

- A. See Section 28 00 00.

1.12 WARRANTY

- A. See Section 28 00 00.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

- A. Network Switch:
1. Connect ACAMS components to ports on the TCP/IP OFOI network switch.
 2. Coordinate with Owner's IT staff:
 - a. IT security policy requirements for ACAMS components.
 - b. MAC addresses and port configuration requirements for each ACAMS component.
- B. ACAMS Server and Software:
1. The campus ACAMS is being procured and will be installed prior to construction of this project.
 2. The ACAMS shall be based on the existing campus Lenel S2 system

2.2 PRODUCTS FURNISHED BY OTHERS

- A. Electrified Door Hardware and Locking Devices:
1. Provided by Division 8 contractor.
 - a. Coordinate with Division 8 to ensure correct electrical and wire harness configuration.

2.3 ACCESS CONTROL AND ALARM MONITORING SYSTEM

- A. General:
1. Provide the ACAMS with DGPs and field devices to the existing campus system.
 2. Communicate with DGPs using Ethernet 10/100, TCP/IP network connection.
 3. Provide the ACAMS programming, graphic screens, and data entry for this project's devices.
 4. Must be compatible with Lenel S2
- B. Manufacturer: Mercury field panels compatible with Lenel S2.

- C. UPS:
 - 1. Meet requirements detailed in Section 28 00 00.
 - 2. Provide UPS power for: network switches.

2.4 DATA GATHERING PANELS (DGP):

- A. General:
 - 1. Future DGP capacity: provide spare capacity in the DGPs to accommodate future growth of the system:
 - a. Distribute future capacity equally among DGPs.
 - b. Card readers 10%.
 - c. I/O points 10%.
 - d. Exception – single door controllers mounted at the door require no spare capacity.
 - 2. Provide battery backup specified in Section 28 00 00.
 - 3. Provide power supply monitoring of:
 - a. AC power loss.
 - b. Low battery and battery presence.
 - 4. OSDP compliant.
 - 5. NEMA 1 enclosure with lock and tamper switch:
- B. Manufacturer: Mercury Security.

2.5 LOCK POWER SUPPLIES:

- A. General:
 - 1. Resettable overcurrent circuit protection for each lock circuit.
 - 2. Fire alarm disconnect individually selectable for each lock circuit.
 - 3. Low battery disconnect to prevent deep discharge of battery during AC power failure.
 - 4. Configure the power supplies capacity to match the spare capacity of the field panels.
 - 5. Provide fault monitoring capability of:
 - a. AC power loss.
 - b. Low battery and battery presence.
 - c. Fire alarm disconnect activation.
 - 6. Provide battery backup specified in Section 28 00 00.
 - 7. NEMA 1 enclosure with lock and tamper switch.
- B. Manufacturer:
 - 1. Alarm-Saf.
 - 2. Altronix.
 - 3. LifeSafety Power.

2.6 UPS:

- A. See Section 28 00 00.

2.7 CARD READERS, CARDS AND DOOR HARDWARE

- A. Card Readers:
 - 1. Coordinate with the Owner for compatibility with their campus standard.
 - 2. Manufacturers
 - a. Mullion, HID Signo Reader 20.
 - b. Full size single gang, HID Signo Reader 40.
 - c. Full size single gang with keypad, HID Signo Keypad Reader 20.

- d. OSDP communication required
- 3. Use non-metallic mud rings:
 - a. Use UL rated mud rings in fire rated corridors:
 - 1) Manufacturer: Thomas & Betts/Carlton.

2.8 SURGE PROTECTIVE DEVICES (SPD):

- A. See Section 28 0000.

2.9 REX PIR SENSORS:

- A. Manufacturers:
 - 1. BEA - R2E series.
 - 2. Bosch - DS16x series.
 - 3. Securitron - SMS series.
 - 4. Kantech – TREX series.

2.10 DOOR POSITION SWITCHES:

- A. For glass doors, use bonding sensor in the electromagnetic Lock.
- B. Recessed door/window switches:
 - 1. Provide double pole switch.
 - 2. Manufacturer:
 - a. GRI.
 - b. Magnasphere - MSS-300C Series.
 - c. Honeywell - 947 series.
 - d. Magnasphere - MSS-3xxS series.

2.11 DOOR MANAGEMENT ALARM (DMA):

- A. General:
 - 1. Provide the DMA to annunciate door prop conditions locally and report the alarm to the ACAMS after an adjustable time-delay.
 - 2. Provide input for remote bypass of the unit.
 - 3. Provide a key switch to bypass the unit.
 - 4. Provide ACAMS output to control bypass.
 - 5. Report: bypass, alarm, and fault, to the ACAMS.
- B. Manufacturers:
 - 1. DSI - ES4200 series.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to Section 28 00 00 General Security Requirements.
- B. See Section 28 05 13 for Security Cable Installation requirements.
- C. See Section 28 00 00 for Security System Label requirements.
- D. See Section 28 00 00 for Commissioning of Electronic Security System requirements.

- E. Coordinate installation activities with the following Divisions or groups:
 - 1. Division 8 – Door hardware, doors, and frames.
 - 2. Division 26 – Electrical power and pathways.
 - 3. Division 27 – Telecom voice and data cabling.
 - 4. Authority Having Jurisdiction for life-safety requirements.
 - 5. Fire alarm contractor.
 - 6. Owner's IT group.

 - F. Field verify the exact location, position, and mounting for all ACAMS equipment prior to installation.

 - G. Install all system components including Owner furnished equipment, and accessories in accordance with the manufacturer's instructions, and furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- 3.2 INSTALLATION
- A. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.

 - B. IT coordination:
 - 1. Coordinate with Owner IT representative on IP addressing and IT security policies.
 - 2. Set up secure access for both browser based, and mobile platform.

 - C. Software and firmware:
 - 1. All software and firmware found in products shall be the latest and most up-to-date provided by the manufacturer.
 - 2. Coordinate with Owner on passwords for all users.
 - 3. Change all default passwords.

 - D. Access Controllers:
 - 1. Mount access controllers to plywood wall panel:
 - a. Do not mount to unpainted plywood.
 - b. Notify the GC and Engineer of unpainted plywood.
 - 2. Connect controllers to metal raceway using knockouts and rigid couplers or chase nipples to prevent exposed or visible cables entering units.
 - 3. Align and mount power supplies underneath each controller.

 - E. Card Readers and Integrated Card Reader Locks:
 - 1. Provide factory recommended cable.
 - 2. Connect card reader tamper switch (if applicable).
 - 3. Mount card readers to electrical box following painting and finishing of walls.
 - 4. Install card reader cables from DGP in continuous lengths without splices.
 - 5. Connect card reader pigtail-wires using butt splice in-line connectors.
 - 6. Connect Integrated Card Reader Locks using manufacturer recommended modular connectors.
 - 7. Leave shield and drain wire floating at reader end, insulate exposed wire to prevent ground loops.
 - 8. Ground the shield and drain wire at DGP.

 - F. Surge Protective Devices (SPD):
 - 1. Install SPDs to protect:
 - a. The 120 VAC line power: for the DGPs and power supplies.

- b. The security devices located outside of a building connected via metallic signal and/or power lines.
 2. When devices or control panels are connected to exterior metallic conductors, including underground metallic conductors, install SPDs at both ends of the conductor.
 3. Install SPD(s) at the DGP input/output circuit, and power supply (if applicable) for all metallic data, signal, and power lines to the exterior devices.
 4. Match SPD equipment to the protected equipment, including wire sizes, operating voltages, currents and number of conductors.
 5. Install SPDs with hardwired low-voltage circuit lead lengths (conductor/wire distance) a minimum of 3 wire feet, (unless otherwise specified by manufacturer) and that the referenced ground connections are of a lesser distance (conductor/wire length).
 6. All required surge protection must be properly installed, according to manufacturer instructions, prior to applying power or connecting signaling conductors to electronic components.
 - G. Door Hardware:
 1. Report to the GC and Engineer, on discovery, any door-frames that are not properly prepped for the electrified hardware and door contact.
 2. Route power to electrically controlled locks on life-safety doors through fire alarm interface relays for door unlock on fire alarm activation.
 3. Coordinate the installation and termination of the security cable with the installation of the electric door locks and power transfer device.
 4. Use cable harness with manufacture recommended modular connectors when connecting to electrified locks and power transfer devices. Do not remove device modular connectors to splice harness wires.
 5. For door strikes and mortise locks: connect the strike latchbolt monitor switch and the lock status monitor switch in series with door position switch so any switch will activate indicating door not secured.
 - H. Fire Doors:
 1. Labeled fire doors and frames may not be drilled, or in any way modified without approval of the AHJ and the architect.
 - I. Door Contacts:
 1. Install contacts in pre-prepped holes from manufacturer.
 - J. REX PIR Installation:
 1. Install and adjust the PIR sensor to prevent under-door spoof threat.
 - a. Position and aim the PIR sensor so that it will not activate from objects slid under the door.
- ### 3.3 SOFTWARE CONFIGURATION
- A. Implement cyber security requirements: see Section 28 00 00.
 - B. Schedule a system configuration meeting and discuss the following with the Owner and the Engineer:
 1. Review and establish the programming details.
 2. Card reader, input, and output naming convention.
 3. Cardholder data import file, including the file format requirements.
 4. Video surveillance integration.
 5. Alarm notification:
 - a. Message format.
 - b. Camera call-up assignments.
 - c. Notifications priority assignments.

- d. Alarm routing to operator workstation(s).
 6. Graphic maps:
 - a. Graphic detail per screen.
 - b. Alarm icons and controls per screen.
 - c. Menu navigation.
 7. Reports for audit trail, device status, access control and alarm database.
 - a. Canned and configurable reports.
 8. Document the results of the meeting and submit for owner approval prior to the start of system programming/configuration.
- C. Create and maintain hard copy worksheets to document the programming and configuration:
1. Submit worksheets for owner approval prior to start of programming.
 2. Keep worksheets up to date on a daily basis.
 3. Submit worksheets with the closeout submittal.
- D. Develop system graphics and maps:
1. Request the current floor plan CAD files to develop graphic maps.
 2. Include icons for doors, alarm points, tamper circuits.
 3. Icons to indicate alarm, trouble and normal states.
 4. Operator control icons for outputs, camera call-up and software controls.
- E. Structure the programming to allow the field devices and control panels to operate independently of the host computer wherever possible.
- F. Structure the programming to minimize the user effort to maintain and administer the system.
- G. Load cardholder database provided in an electronic file from the Owner.
- H. Program and setup the system to require no additional programming by the Owner.
- I. Customize menus with the assistance of the factory to "gray-out" features not used on project.
- J. System software backup:
1. Maintain a complete, up-to-date backup of the system configuration and database.
 2. Maintain copies on a rotating basis, until final acceptance by Owner.

3.4 SYSTEM INTEGRATION

- A. Video Surveillance System Integration:
1. Automatic video call-up:
 - a. Configure alarm notification to call-up cameras associated with the alarm to the screen of the ACAMS alarm operator workstation.
 - b. Provide associated pre and post alarm camera video clips of 10 seconds of video before the alarm and 30 seconds after the alarm.
 - c. These automated features will not require a manual video search.
 2. Record all cameras associated with the alarm for forensic analysis, including pre and post alarm video.
 3. Camera call-up and control from ACAMS graphic screens.

3.5 CLOSEOUT ACTIVITIES

- A. Testing and commissioning: see Section 28 00 00 for testing and commissioning requirements.

- B. Training: see Section 28 00 00 for operation, administration and maintenance training requirements.
- C. Submit As-Built drawings.
- D. Submit final programming and setup parameters, in electronic format.
- E. Provide backup copy of all system software and configuration data.
- F. Provide instructions on system back-up and recovery procedures.

End of Section

SECTION 28 14 00 - ELEVATOR LANDING COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working intercom and entry control installation, as described in these specifications.
- B. Section includes:
 - 1. Elevator landing 2-way communications system:
 - a. Calling Stations.
 - b. Base Station.
- C. Products installed but not furnished under this section:
 - 1. Coordination to remain a requirement of this section.
 - 2. Structured cable and outlets (by division 27).
 - 3. Network switch(s).
- D. Related requirements
 - 1. Section 07 84 00 Firestopping.
 - 2. Section 26 00 00 Electrical.
 - 3. Section 27 00 00 Communications.
 - 4. Section 28 00 00 General Security System Requirements.
 - 5. Section 28 05 13 Security System Cabling.
 - 6. Section 28 13 00 Access Control and Alarm Monitoring System.

1.2 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. See Section 28 00 00
- B. Definitions:
 - 1. See Section 28 00 00

1.3 SYSTEM DESCRIPTION

- A. Elevator Landing 2-way Communications System Overview:
 - 1. The Elevator Landing Communication System consist of Calling Stations (substations), Master Station, and the connection to the campus emergency communication system.
 - 2. Comply with California State Fire Marshal requirements.
 - 3. This system is an Emergency Communications System as defined in NFPA 72 Chapter 24.
 - 4. Provide callings stations, and control equipment as shown on drawings.
 - 5. Provide Master Station:
 - a. The location in the Fire Control Room has not been coordinated with the Authority Having Jurisdiction, this coordination is a requirement of the contractor.
 - 6. Provide the following functions:

- a. The emergency communication system must be usable for people with hearing impairments, speech impairments, and difficulty reaching.
- b. A system with both visible and audible signals allows people with hearing or speech difficulties to receive information.
- c. A light indicating the call was received and a voice intercom make the system more accessible in an emergency.
- d. Push to talk Call Stations, a handset is not acceptable.
- e. Unanswered calls roll over to the 24x7 staffed campus Emergency Communication System.
- f. The roll over call must establish a 2-way communication with the between the calling station and the receiving party, a recorded message only is not acceptable.
- g. Duplex audio communication between Call Stations and Base Station.
7. Battery backup is required per NFPA 72.
8. The system and installation must comply with all the relevant requirements of the California Building Code (CBC) including Section 1009.8.
9. Area of Refuge signage will be provided by others

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 1. Coordinate with Division 26 on electrical infrastructure requirements.
 2. Coordinate with Division 27 on telecom cabling and infrastructure requirements.
 3. Coordinate with Owner's physical security representative include:
 - a. User access rights.

1.5 SUBMITTALS

- A. Provide submittals according to Section 28 00 00 General Security Requirements.

1.6 QUALITY ASSURANCE

- A. See Section 28 00 00.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Section 28 00 00.

1.8 SITE CONDITIONS

- A. See Section 28 00 00.

1.9 WARRANTY

- A. See Section 28 00 00.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

- A. Network switches.

2.2 PRODUCTS NOT FURNISHED UNDER THIS SECTION:

- A. Coordination to remain a requirement of this section.
- B. Network switch.
- C. CBC required signage.

2.3 ELEVATOR LANDING 2-WAY COMMUNICATION SYSTEM

- A. General:
 - 1. Install the system per CBC 1009.8 and NFPA 72 chapters 12, 23, and 24 requirements, including the use of 2-hour rated Circuit Integrity (CI) cable.
 - 2. A network switch dedicated to the Elevator Landing Communication System will be provided by the campus and installed in the BDF.
 - 3. Provide a UPS for the PoE switch:
 - a. Comply with NFPA 72 power requirements.
 - b. See Section 28 00 00 for the 24-hour UPS requirements.
- B. Elevator landing calling stations:
 - 1. Provide stations as indicated on the floor plans and connect to the Campus Emergency Communication System (ECS), using the Zenitel AlphaCom Server.
 - 2. Modify the station LED lights to comply with the Visible Communication Method called out in CBC 1009.8.1.1 "A button complying with Section 1138A.4 or Sections 11B-205 and 11B-309 in the area of refuge shall activate both a light in the area of refuge indicating that rescue has been requested and a light at the central control point indicating that rescue is being requested. A button at the central control point shall activate both a light at the central control point and a light in the area of refuge indicating that the request has been received."
 - a. LED control may be by programming or auxiliary relays.
 - 3. Manufacturer: Zenitel TMIS-2
- C. Master station:
 - 1. Provide a Master Station per the drawings:
 - a. Connect to the campus ECS.
 - b. Modify the station LED lights to comply with the Visible Communication Method above.
 - c. Coordinate with the AHJ on location.
 - 2. Manufacturer: Zenitel CRM-V

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to Section 28 00 00 General Security Requirements.
- B. See Section 28 05 13 for Security Cable Installation requirements.
- C. See Section 28 00 00 for Security System Label requirements.
- D. See Section 28 00 00 for Commissioning of Electronic Security System requirements.
- E. Coordinate installation activities with the following Divisions or groups:
 - 1. Division 26 – Electrical power and pathways.
 - 2. Division 27 – Telecom voice and data cabling.
 - 3. Campus IT group.

- F. Field verify the exact location, position, and mounting for all equipment prior to installation.
- G. Install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

3.2 INSTALLATION

- A. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- B. Provide manufacturer recommended communication and power cables.
- C. IT coordination:
 - 1. Coordinate with Owner IT representative on IP addressing and IT security policies.
 - 2. Set up secure access for both browse- based, and mobile phone or tablet-based user interfaces.
- D. Software and firmware:
 - 1. All software and firmware found in products shall be the latest and most up to date provided by the manufacturer.
 - 2. Coordinate with Owner on passwords for all users.
 - 3. Change all default passwords.

3.3 CLOSEOUT ACTIVITIES

- A. Testing and commissioning: see Section 28 00 00 for testing and commissioning requirements.
- B. Training: see Section 28 00 00 for operation, administration and maintenance training requirements.
- C. Submit As-Built drawings.
- D. Submit final programing and setup parameters, in electronic format.
- E. Provide backup copy of all system software and configuration data.

END OF SECTION 28 1400

SECTION 282300 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. General: Provide engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction, and special or occasional services as required to make a complete working video surveillance system installation, as described in the contract documents.
- B. Section Includes:
 - 1. Video Surveillance System.
 - 2. Network Video Recorder(s).
 - 3. Surveillance cameras.
 - 4. Workstations.
 - 5. Network communication.
- C. Related Sections:
 - 1. Section 07 84 00 Firestopping.
 - 2. Section 26 00 00 Electrical.
 - 3. Section 27 00 00 Communications.
 - 4. Section 28 00 00 General Security Requirements.
 - 5. Section 28 05 13 Security System Cabling.
 - 6. Section 28 13 00 Access Control and Alarm Monitoring System.
 - 7. Section 28 14 00 Intercom and Elevator Landing Communication.

1.2 REFERENCES

- A. See Section 28 00 00.

1.3 SYSTEM DESCRIPTION

- A. Provide an IP Video Surveillance System (VSS) that is an extension of the existing campus VSS. Provide all equipment and work required for extension of the VSS to the existing system head end with integration ACAMS.
 - 1. Provide UPSs for Owner supplied network communications equipment (see Section 28 00 00).
- B. Coordinate all work with applicable trades.

1.4 CYBER SECURITY

- 1. See Section 28 00 00.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. See Section 28 00 00.

1.6 SUBMITTALS

- A. See Section 28 00 00.

1.7 QUALITY ASSURANCE

- A. See Section 28 00 00.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. See Section 28 00 00.

1.9 FIELD CONDITIONS

- A. See Section 28 00 00.

1.10 WARRANTY

- A. See Section 28 00 00.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

- A. Network Switch:
 - 1. Connect ACAMS components to ports on the TCP/IP OFOI network switch.
 - 2. Coordinate with Owner's IT staff:
 - a. IT security policy requirements for VSS components.
 - b. MAC addresses and port configuration requirements for each VSS component.
- B. VMS Server and Software:
 - 1. The campus VMS is being procured and will be installed prior to construction of this project.
 - 2. System shall be Lenel (S2), no substitutes
- C. UPS:
 - 1. Coordinate with Owner on backup power requirements detailed in Section 28 00 00 for Network switches supporting the ACAMS and VSS.

2.2 PRODUCTS PROVIDED BY OTHERS

- A. Camera UTP cabling (By division 27).
- B. Camera structured cabling to the equipment rack patch panel.

2.3 CAMERAS

- A. Camera requirements.
 - 1. See drawings for minimum camera resolution.
 - 2. Compatible with the VMS.
 - 3. ONVIF Profile S or ONVIF Version 1.01 or higher.
 - 4. Support Quality of Service (QoS) to be able to prioritize traffic.
 - 5. Support MJPEG, MPEG and H.264 encoding.
 - 6. Support Unicast and multicast transport.
 - 7. Multi-stream - at least two individually configurable full resolution full frame rate IP video streams.

8. Provide the ability to backup and restore camera settings through an embedded Web browser.
 9. Provide simple motion detection to detect motion within a user-defined field of view or within a user specified rectangular zone.
 10. Use IR-sensitive progressive scan sensor.
 11. Day-night Color/B&W camera with mechanical IR cut filter.
 12. Auto-iris.
 13. Provide both landscape format (4:3 and 16:9 aspect ratio) as well as portrait format (3:4 and 9:16 aspect ratio).
 14. Vandal resistant.
 15. Exterior cameras:
 - a. Rated for IP66 exterior application.
 - b. Support operation between -40 to +130°F.
 - c. Dome cameras to have clear domes for improved low-light sensitivity.
 16. Provide Wide Dynamic Range Feature.
- B. Fixed Dome Cameras:
1. IEEE 802.3af (Power over Ethernet).
 2. Smoked colored lower dome for interior cameras.
 3. See drawings for camera resolution, minimum resolution of 1080p.
 4. Motorized vari-focal lens sized to provide the owner approved field of view.
 5. Day/Night feature with IR filter.
 6. Vandal resistance: IK10.
 7. Manufacturer: Axis P32 series.
- C. Dual-imager Camera:
1. Provide dual mini-dome camera with fixed lenses that meet the Owner's viewing requirements.
 2. Minimum total resolution 4MP.
 3. Vandal resistance: IK10.
 4. Manufacturer: Axis P3715-PLVE.
 5. .
- D. 270 Degree Multi-imager Cameras:
1. Provide 270° or 360° field-of-view with multiple imagers.
 2. Minimum total resolution 15MP.
 3. Remote setup of individual imagers.
 4. IR illuminators
 5. Vandal resistance: IK09.
 6. Manufacturers:
 - a. Axis P3719-PLE.
- E. 180 Degree Multi-imager Cameras:
1. Provide 180° field-of-view with multiple imagers.
 2. Minimum total resolution 15MP.
 3. Factory focused lenses.
 4. Vandal resistance: IK10.
 5. Manufacturers:
 - a. Axis Q3708-PVE.
- F. Panoramic Camera:
1. Provide 360-degree field-of-view camera with dewarping software.
 2. Single imager.
 3. Minimum resolution 12MP.
 4. Manufacturer: Axis M3058-PLVE

2.4 SURGE PROTECTIVE DEVICES (SPD):

- A. See Section 28 0000.

PART 3 - EXECUTION

3.1 GENERAL

- A. See Section 28 00 00 General Security Requirements.
- B. See Section 28 05 13 for Security Cable Installation requirements.
- C. See Section 28 00 00 for Security System Label requirements.
- D. See Section 28 00 00 for Commissioning of Electronic Security System requirements.
- E. Coordinate installation activities with the following Divisions or groups:
 - 1. Division 26 – Electrical power and pathways.
 - 2. Division 27 – Telecom voice and data cabling.
 - 3. Owner's IT group.
- F. Field verify the exact location, position, and mounting for all VSS equipment prior to installation.
- G. Install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- H. Equipment power: see Section 28 00 00.

3.2 INSTALLATION

- A. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- B. Equipment Rack:
 - 1. Rack mount UPS units located in the equipment racks/cabinets.
- C. IT coordination:
 - 1. Coordinate with Owner IT representative on IP addressing and IT security policies.
 - 2. Set up secure access for VSS viewers, both browser-based, and mobile phone or tablet based.
- D. Software and firmware.
 - 1. All software and firmware found in products shall be the latest and most up to date provided by the manufacturer.
 - a. Provide cameras with the current version of firmware, unless the provider of the VMS or NVR requires a different version.
 - 2. See Section 28 00 00 on cyber security requirements.
- E. Surge Protective Devices (SPD):
 - 1. Install SPDs to protect:

- a. The 120 VAC line power to the VSS equipment.
 - b. The VSS devices located outside of a building connected via metallic signal and/or power lines.
 2. When VSS devices are connected to exterior metallic conductors, including underground metallic conductors, install SPDs at both ends of the conductor.
 3. Match SPD equipment to the protected equipment, including wire sizes, operating voltages, currents and number of conductors.
 4. Install SPDs with hardwired low-voltage circuit lead lengths (conductor/wire distance) a minimum of 3 wire feet, (unless otherwise specified by manufacturer) and that the referenced ground connections are of a lesser distance (conductor/wire length).
 5. All required surge protection must be installed, according to manufacturer instructions, prior to applying power or connecting signaling conductors to electronic components.
 - F. Interconnection of rack mounted video equipment:
 1. Connect signal paths between video equipment as required:
 - a. Cables shall be as short as practicable for each signal path without causing strain at the connectors.
 - b. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.
 - c. Use cable managers to reduce cable strain and provide a neat cable appearance.
 - d. Observe cable manufacturer's bend radius requirements.
 - G. Cameras:
 1. Coordinate with Owner security representative on field of view for each camera.
 2. Focus the lens to give a sharp picture (to include checking for day and night focus and image quality) over the entire field of view.
 3. Set PTZ cameras preset positions and privacy areas.
 4. Provide an electrical ground for all exterior cameras per the SPD manufacturer's requirements.
 - H. Camera Housings, Mounts, and Poles:
 1. Install the camera housings and mounts as specified by the manufacturer and as shown.
 2. Provide mounting hardware sized appropriately to secure each camera, housing and mount with maximum wind and ice loading encountered at the site.
 3. Provide a foundation for each camera pole as specified and shown.
 4. Provide a ground rod for each camera pole.
 - a. Connect the camera pole to the ground rod as specified in Division 26 and the applicable building codes.
 - I. Network Video Recorder (NVR):
 1. See Section 28 00 00 for emergency power requirements.
 - J. Integrate with ACAMS as called for in Section 281300.
- 3.3 NETWORK CONFIGURATION
1. SNMP - Configure the SNMP monitoring application to monitor traps and notify for faults including:
 - a. Camera faults
 - b. ACAMS server faults
 - c. NVR faults
 - d. Disk drive faults
 - e. Network switch ports faults
 - f. ACAMS power supply faults (if supported)

2. Network Time
 - a. Synchronize all network devices to the time server.

3.4 SOFTWARE CONFIGURATION

- A. Implement cyber security requirements: see Section 28 00 00.
- B. Schedule a system configuration meeting and discuss the following with the Owner and the Engineer:
 1. Review and establish the programming details.
 2. camera naming convention.
 3. ACAMS integration.
 4. Camera recording requirements.
 - a. Schedules for camera recording.
 - b. Frame rate and resolution settings.
 - c. Online video storage requirements.
 - d. Offline storage.
 5. Network security requirements.
 6. VSS workstation.
 - a. Workstation and video monitor(s) setup.
 - b. Graphic User Interface programming.
 7. Browser based and mobile phone/tablet-based viewers.
 8. Field of view requirements for each camera.
 9. Motion detection zones for each camera.
 10. Document the results of the meeting and submit for owner approval prior to the start of system programming/configuration.
- C. Create and maintain worksheets to document the programming and configuration:
 1. Submit worksheets for owner approval prior to start of programming.
 2. Keep worksheets up to date daily.
 3. Submit worksheets with the closeout submittal.
- D. Structure the programming to minimize the user effort to maintain and administer the system.
- E. Maintain a complete, up-to-date backup of the system configuration and database:
 1. Maintain copies on a rotating basis, until final acceptance by Owner.
- F. System software backup:
 1. Maintain a complete, up-to-date backup of the system configuration and database.
 2. Maintain copies on a rotating basis, until final acceptance by Owner.

3.5 SYSTEM INTEGRATION

- A. ACAMS Integration: See Section 28 13 00.

3.6 CLOSEOUT ACTIVITIES

- A. Testing and commissioning: see Section 28 00 00 for testing and commissioning requirements.
- B. Training: see Section 28 00 00 for operation, administration and maintenance training requirements.
- C. Submit As-Built drawings.

- D. Submit final programing and setup parameters, in electronic format.
- E. Provide backup copy of all system software and configuration data.
- F. Provide instructions on system back-up and recovery procedures.

End of Section

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This work includes designing and providing a new, completely supervised, multiplexed, addressable, intelligent, analog fire alarm system (devices, components and wiring) as described herein and on the contract drawings for the Project.
1. NO SUBSTITUTIONS: Provide a new fire alarm system exclusively consisting of a Gamewell fire alarm panel and all associated products for a complete fire alarm system, except where otherwise indicated.
 2. Include all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, software and programming, acceptance testing and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide equipment with components identical to and bearing the labeling of those approved for intended use by independent testing laboratory.
- B. Section Includes:
1. Fire-alarm control unit.
 2. Manual fire-alarm boxes.
 3. System smoke detectors.
 4. Air-sampling smoke detectors.
 5. Nonsystem smoke detectors.
 6. Heat detectors.
 7. Notification appliances.
 8. Device guards.
 9. Remote annunciator.
 10. Addressable interface device.
 11. Digital alarm communicator transmitter.
 12. Notification appliance circuit power extender panel (NAC).
 13. Network communications.
- C. Related Requirements:
1. Section 013573 "Delegated Design Requirements and Procedures" for definitions, submittal procedures, responsibilities, and scheduling requirements associated with delegated design assignment indicated in this Section.
 2. Division 07 Section "Penetration Firestopping" • • for fire stopping requirements not in this Section.
 3. Provisions of Division 26 Sections "Common Work Results for Electrical" • • and Raceways and Boxes for Electrical Systems" • • apply to this Section.
 4. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.2 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.

- B. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and attachments to other work.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 - 4. Detail assembly and support requirements.
 - 5. Include voltage drop calculations for notification-appliance circuits.
 - 6. Include battery-size calculations.
 - 7. Include input/output matrix.
 - 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 - 9. Include performance parameters and installation details for each detector.
 - 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show field wiring required for HVAC unit shutdown on alarm.
 - b. Locate detectors according to manufacturer's written recommendations.
 - 12. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 - 13. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

- C. General Submittal Requirements:
 - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.
 - c. Licensed or certified by authorities having jurisdiction.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- C. Field quality-control reports.

- D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - h. Manufacturer's required maintenance related to system warranty requirements.
 - i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
- B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 5. Keys and Tools: One extra set for access to locked or tamperproofed components.
 6. Audible and Visual Notification Appliances: One of each type installed.
 7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

- B. Installer Qualifications: Installation shall be by personnel certified by NICET as minimum fire-alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.8 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified FM Global-placarded addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- B. Automatic sensitivity control of certain smoke detectors.
- C. All components provided shall be listed for use with the selected system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Automatic sprinkler system water flow.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances, including voice evacuation notices.
 - 2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station.
 - 4. Activate voice/alarm communication system.
 - 5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - 6. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 7. Recall elevators to primary or alternate recall floors.

8. Activate emergency lighting control.
9. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Duct smoke detector.
3. User disabling of zones or individual devices.
4. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.
11. Loss of communication between remote call stations and master control station for two-way communication system for rescue assistance.
12. Open circuits, shorts, and grounds in circuits in two-way communication system.
13. Open circuits, shorts, and grounds in telephone circuits in two-way communication system.
14. Power supply trouble in two-way communication system.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Gamewell.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.

- c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- D. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 1. Annunciator and Display: Liquid-crystal type, two line(s) of 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- E. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 1. Pathway Class Designations: NFPA 72, Class B.
 2. Pathway Survivability: Level 1.
 3. Install no more than 256 addressable devices on each signaling-line circuit.
 4. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - c. One USB port for PC configuration.
 - d. One RS 232 port for voice evacuation interface.
- F. Smoke-Alarm Verification:
 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
 3. Sound general alarm if the alarm is verified.
 4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- G. Notification-Appliance Circuit:
 1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- H. Elevator Recall:
 1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.

- I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- K. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
 - 1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
 - a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
 - 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 - 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- L. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Sealed lead calcium.
- N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. GAMEWELL.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.6 SYSTEM SMOKE DETECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. GAMEWELL.
- B. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
 2. Detectors shall be four -wire type.
 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 6. Integral Visual-Indicating Light: LED type, indicating detector has operated[and power-on status].
 7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Multiple levels of detection sensitivity for each sensor.
 - d. Sensitivity levels based on time of day.
- C. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- D. Ionization Smoke Detector:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

- E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 - 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 - 4. Each sensor shall have multiple levels of detection sensitivity.
 - 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.7 NONSYSTEM SMOKE DETECTORS

- A. General Requirements for Nonsystem Smoke Detectors:
 - 1. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
 - 2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.
- B. Single-Station Duct Smoke Detectors:
 - 1. Comply with UL 268A; operating at 120-V ac.
 - 2. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot when tested according to UL 268A.
 - 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
 - a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.
 - 4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.8 NOTIFICATION APPLIANCES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Wheelock.
 - 2. GAMEWELL.
- B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

- D. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
- E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- F. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, white.
- G. Voice/Tone Notification Appliances:
 - 1. Comply with UL 1480.
 - 2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - 3. High-Range Units: Rated 2 to 15 W.
 - 4. Low-Range Units: Rated 1 to 2 W.
 - 5. Mounting: [Flush] [semirecessed] [or] [surface mounted and bidirectional].
 - 6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.9 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers, fire pumps, and emergency generators for monitoring status
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.
 - 1. Allow the control panel to switch the relay contacts on command.
 - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

- D. Control Module:
 - 1. Operate notification devices.
 - 2. Operate solenoids for use in sprinkler service.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply.
 - 5. Loss of power.
 - 6. Low battery.
 - 7. Abnormal test signal.
 - 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 NETWORK COMMUNICATIONS

- A. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.
- B. Provide integration gateway using BACnet for connection to building automation system.

2.13 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - 1. Factory fabricated and furnished by device manufacturer.
 - 2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ELECTRIC POWER

- A. Provide primary power for all fire alarm panel equipment from the emergency AC service to the building where shown on the drawings. Power shall be 120 VAC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices. Make the service connection for the fire alarm panel equipment at the junction box labeled "FACP Connection" connected to the emergency distribution panel where shown. The circuit breaker shall be painted red, marked "Fire Alarm Control Circuit" and shall be provided with a lockable handle or cover. All 120 VAC primary power circuits shall be equipped with surge protection devices (SPD).

3.3 SYSTEM FIELD WIRING

- A. Wiring within Cabinets, Enclosures, Boxes, Junction Boxes and Fittings:
 - 1. Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure or cabinet.
 - 2. Connect conductors which are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting or junction box, to terminal blocks.
 - 3. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with approved pressure type terminal blocks, which are securely mounted.
 - 4. Wire nuts and similar devices are not acceptable.
- B. Provide a terminal cabinet where indicated on the Drawings.
 - 1. Use terminal sizes appropriate for the size of the wiring to be connected.
 - 2. Provide labeling of conductor terminations, and a diagram permanently mounted in the terminal cabinet, showing all conductors, their labels, their circuits and their interconnection.
 - 3. Provide terminal cabinets having 25 percent spare backbox space.
- C. Fire Alarm Wiring:
 - 1. Provide fire alarm circuits in accordance with the equipment manufacturer's requirements, NFPA 70 – National Electrical Code, specifically Article 760 and these Specifications. Provide wire size sufficient to prevent voltage drop problems.
 - 2. Circuits operating at 24 VDC shall not operate at less than 21.6 volts.
 - 3. Audio speaker circuits operating at 70.7 VRMS shall be designated to operate at less than 0.5 dB (12.5 percent) loss. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.
 - 4. Install all conductors in minimum electrical-metallic tubing (EMT), with a minimum diameter of 3/4 inch.
 - 5. Use shielded wiring where recommended by the manufacturer. For shielded wiring, the shield shall be grounded at only one point, which shall be in or adjacent to the FACP. Treat the drain or shield wires as a fire alarm conductor, landed on terminal strips. The drain wire shall be sleeved or insulated to within 1 inch of its termination. T-taps are not permitted. Circuits to fan shutdown systems shall terminate in terminal cabinets within 3 feet of the controllers for those systems

D. Wiring Installation:

1. All alarm initiating devices and supervisory initiating devices shall be connected on Style 4 two (2) wire (Class B) Signaling Line Circuits (SLC). Unsupervised wiring (point wires) shall not be permitted. Parallel branch circuit wiring shall be permitted on the addressable SLCs.
2. All alarm indicating devices shall be connected on Style Y two (2) wire electrically supervised circuits and on a minimum of two active circuits.
3. Wiring to initiating and supervisory devices and to fire alarm annunciators shall be with two (2) conductor twisted size 16 solid copper UL listed fire alarm system wire, subject to manufacturer's recommendations.
4. Wiring to alarm indicating devices shall be with two (2) conductors twisted No. 14 AWG solid copper UL listed jacketed fire alarm system wire, subject to manufacturer's recommendations.
5. Power wiring, operating at 120 VAC minimum, shall be No. 12 AWG solid copper, 600 VAC rated THHN/THWN insulation.
6. All other wiring shall be solid copper No. 14 AWG minimum with 600 volt THHN insulation except as specifically noted.
7. No splicing of wires is permitted except on terminal blocks in annunciators, control panels or properly labeled terminal cabinets as shown on the drawings.
8. The use of wire nuts or similar type devices is not permitted.

E. Conductor Terminations:

1. All devices shall have terminals for each wiring connection.
2. No splicing of any type shall be permitted in pull boxes, to include crimp terminals.
3. No specific color coding is required for any circuit; however, labeling of any circuit at terminal blocks in terminal cabinets, FACP, and remote fire alarm control units shall be provided at each conductor connection.
4. Each conductor or cable shall have a permanent label to provide a unique and specific designation.
5. Each terminal cabinet, FACP and remote fire alarm control unit shall contain a laminated drawing which indicates each conductor, its label, circuit and terminal. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel or unit so that it does not interfere with the wiring or terminals.
6. All wires shall be labeled at both ends.. Use plastic wire ties and wire tie mounts to ensure a neat quality appearance.

F. Conduit Installation:

1. Conceal all electrical conduits above suspended ceilings and behind walls, except in unfinished areas where conduit may be surface mounted, unless otherwise specified.
2. The use of metal clad (MC) cable is acceptable only in concealed spaces and only as allowed by other Codes, including channeled walls and above suspended ceilings. The MC Cable shall be installed and supported in accordance with NFPA 70-NEC.
3. MC cable is not acceptable for smoke control system wiring.
4. All exposed conduit shall be painted to match adjacent finish.

G. Conduit Size:

1. Both exposed and concealed conduit including risers up to 2 inches in diameter shall utilize compression type steel fittings and connectors.
2. Unless otherwise noted, all conduit provided shall be 3/4 inch minimum trade size.
3. Vertical risers shall be one inch diameter minimum.
4. Limited use of 1/2 inch conduit is permitted on horizontal runs when a reduced diameter is required for better concealment. Where necessary, 1/2 inch diameter flex conduit may be fished or used for concealed work. Provide plenum rated wiring conductors (Type FPLP) when flex conduit is used.

3.4 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
1. Devices placed in service before all other trades have completed cleanup shall be replaced.

2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 1. Connect new equipment to existing monitoring equipment at the supervising station.
- C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Manual Fire-Alarm Boxes:
 1. Install manual fire-alarm box adjacent to FACP.
 2. Mount manual fire-alarm box on a background of a contrasting color.
 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- E. Smoke- Detector Spacing:
 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Smooth ceiling spacing shall not exceed 30 feet .
 3. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
 4. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 5. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- H. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.
- I. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- K. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.5 PATHWAYS

- A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
- B. Pathways shall be installed in EMT.
- C. Exposed EMT shall be painted to match adjacent finish.

3.6 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 1. Smoke dampers in air ducts of designated HVAC duct systems.
 2. Alarm-initiating connection to elevator recall system and components.
 3. Alarm-initiating connection to activate emergency lighting control.
 4. Supervisory connections at valve supervisory switches.

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.8 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.9 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.11 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 31 22 00 - EARTHWORK AND GRADING

PART 1 - GENERAL

1.1 SUMMARY:

- A. This section describes general requirements, products, and methods of execution relating to on-site earthwork. Any work within the public right-of-way shall be constructed to the standards of the City of Livermore and State of California Department of Transportation. Work includes, but is not limited to, the following:
1. Grading.
 2. Material.
 3. Excavation.
 4. Filling and backfilling.
 5. Soil Sterilant.
 6. Termiticide.
- B. Provide labor, material and equipment and services necessary to complete the excavations, re-compaction and finish grading as specified and indicated on Drawings.
1. Obtain permit from local authorities.
 2. Provide surveying for grading operations.
 3. Provide shoring design.
 4. Provide dewatering operations.
 5. Provide site grading, cut, fill and finish.
 6. Provide excavation and backfill for filling construction, including trenches within building lines.
 7. Preparation for subgrade for building slabs, walks, pavements, and landscaping.
 8. Provide distribution of stockpiled topsoil.
 9. Provide sub-base course for walks and pavements.
 10. Provide engineered fills for building slabs and foundations.
 11. Provide sand and gravel for capillary break/moisture barrier under building slabs.
 12. Provide sub-surface drainage backfill for walls and trenches.
- C. The work includes removal and legal disposal off the site of debris, rubbish and other materials resulting from clearing and grubbing operations.
1. Work specified in Related Sections:
 - a. Section 31 10 00 – SITE PREPARATION AND DEMOLITION.
 - b. Section 31 23 33 – TRENCHING, BACKFILLING, AND COMPACTING.
 - c. Section 34 47 27 – BIORETENTION

1.2 DEFINITIONS:

- A. Engineered Fill:
1. Soil or soil-rock material approved by District's Representative used by the Contractor in order to raise grades or to backfill excavations.
 2. The District's Testing Agency will make sufficient tests and/or observations for the purpose of issuing a written statement that material meets or exceeds the specification requirements.
- B. On-site Material: Soil or earth material obtained from required on-site excavation.
- C. Excavation: Consists of the removal of material encountered to subgrade elevations and the re-use or disposal of materials removed.
- D. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below sub-base, drainage fill, rock base course, or topsoil materials.
- E. Import Material: Soil material obtained off-site when sufficient approved soil material is not available from excavations.

- F. Base Course: The layer placed between the sub-base and surface pavement in a paving system.
- G. Relative Compaction: In-place dry density of soil expressed as percentage of maximum dry density of same materials, as determined by laboratory test procedure American Society for Testing and Materials (ASTM) D1557.
- H. Overexcavation: Removal of material below required subgrade elevations.

1.3 SUBMITTALS:

- A. Comply with provisions of Section 01 33 00 – SUBMITTAL PROCEDURES.
- B. Product Data: Manufacturer's literature and data, including, where applicable, capacity, labels, or other markings on equipment made to the specified standards for materials, for the following:
 - 1. Imported materials.
 - 2. Class II aggregate base (Caltrans Section 26).
 - 3. Soil Sterilant.
 - 4. Termiticide.
 - 5. Cement Treatment.
 - 6. Geotextiles.
 - 7. Subdrainage Pipe.
- C. Test Reports: Submit the following reports for import material directly to Architect from the Contractor's testing services:
 - 1. Test reports on borrow material.
 - 2. Density test reports.
 - 3. One optimum moisture-maximum density curve for each type of soil encountered.
 - 4. Not used.
 - 5. Not used.
 - 6. Soil percolation rate test for soils to be used in storm water treatment zones.
 - 1)
- D. Shoring Design: Where shoring is required by State Law or Contractor shall provide necessary design, provide proposed excavation shoring method for review prior to commencement of excavation requiring shoring. Include the following information:
 - 1. Basic design assumptions.
 - 2. Design Calculations.
 - 3. Describe materials or shoring system to be used.
 - 4. Indicate whether or not any components will remain after filling or backfilling.
 - 5. The shop drawings for the proposed shoring system.
 - 6. Coordinate with the Construction Documents and identify any proposed modifications or deviations.
 - 7. Certification of the above by a registered professional civil or structural engineer licensed by the State of California.
 - 8. Submittal will be reviewed for general conformance with project plans, but no review of calculations will be provided.
- E. Dewatering Plan: Based upon site surface and subsurface conditions, including available geotechnical and hydrological data, provide a system to perform the following:
 - 1. Lower the ground water level below bottom of excavation.
 - 2. Relieve the hydrostatic pressure below the subgrade to prevent uplift.
 - 3. Prevent surface drainage from accumulating within work area.
 - 4. Legally discharge and dispose of excess water.
 - 5. Submit description of basic components of proposed dewatering system and its planned method of operation.
- F. Samples:
 - 1. 20-lb. samples sealed in air-tight containers, of each proposed fill and backfill soil material from on-site or borrow sources. Provide to Geotechnical Engineer as requested.

2. 20-lb samples sealed in air tight containers of specialty soils for submission to a plant and soil testing facility for analysis. Include perc test and sieve analysis.
- G. Pad Certification
 1. Submit a pad certification stamped by a California Licensed Land Surveyor.
- H. Storm Water Pollution Prevention / Erosion Control Plans/Water Pollution Control Plans
- I. Permit/Notice of Intent (N.O.I.), for discharge of storm run-off from the construction site.
- J. Haul Routes.

1.4 ASSURANCE:

- A. Requirements of Regulatory Agencies:
 1. Comply with State of California Business and Transportation Agency, California Department of Transportation (CDT, Caltrans) "Standard Specifications" (Caltrans Standard Specification).
 2. Comply with State of California Code of Regulations (CCR).
 3. Comply with State of California Construction Safety Orders, Latest Edition (CAL/OSHA).
 4. City of Livermore Department of Public Works, Standards and Specifications and Drawings, latest edition.
 5. BCDC, ACOE, Fish and Wildlife, if applicable.
- B. Soil Testing:
 1. District will engage a geotechnical testing agency, to include testing soil materials proposed for use in the work and for quality control testing during excavation and fill operations.
 2. Test results will be distributed in compliance with Section 014523 – TESTING AND INSPECTION SERVICES.
- C. Codes and Standards:
 1. Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
 2. Statewide General Permit to Discharge Storm Water associated with construction activity.
 3. The project Storm Water Pollution Prevention and Monitoring Plan.
- D. Comply with the latest editions of the following Standards and Regulations:
 1. American Society for Testing and Materials (ASTM):
 - a. Concrete Aggregates.
 - b. C125: Standard Terminology Relating to Concrete and Concrete Aggregates.
 - c. C136: Sieve Analysis of Fine and Coarse Aggregates.
 - d. C566: Total Evaporable Moisture Content of Aggregate by Drying.
 - e. D421: Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
 - f. D422: Particle Size Analysis of Soil.
 - g. D854: Specific Gravity of Soils.
 - h. D1556: Density of Soil by the Sand Cone Method.
 - i. D1557: Laboratory Compaction Characteristics of Soil Using Modified Effort
 - j. D2216: Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
 - k. D2487: Classification of Soils for Engineering Purposes.
 - l. D2922: Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - m. D2937: Density of Soil in Place by Drive Cylinder Method.
 - n. D3017: Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
 - o. D4318: Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 2. California Code of Regulations, Title 24, Part 2 - Basic Building Regulations, Chapter 24 - Excavations, Foundations, and Retaining Walls.
 3. California Department of Transportation (Caltrans) Standard Specifications:
 - a. Section 10: Watering.
 - b. Section 18: Dust Palliatives.

- c. Section 19: Earthwork.
 - 4. CAL/OSHA, Title 8.
 - 5. City of Livermore Standard Plans and Specifications
 - 6. Other authorities having jurisdiction

- E. Geotechnical Engineering Services:
 - 1. Geotechnical Engineer shall be provided by the District or Contractor, as the District's Representative to observe grading observations during preparation offsite, excavation, and compaction of fill materials.
 - 2. Make visits to site to familiarize him generally with progress and quality of work.
 - 3. Make field observations and tests to enable him to form opinions regarding adequacy of site preparation, acceptability of fill materials and extent to which earthwork construction and relative compaction comply with specifications requirements.
 - 4. Examine conditions exposed in foundation excavations.

- F. Site Information:
 - 1. Geotechnical Investigation Reports are available for examination by Contractor.
 - 2. Additional soil borings and other exploratory operations may be made by Contractor at no cost to the District. Submit proposed boring locations for review prior to performing the work.

- G. Contractor Qualifications:
 - 1. Have successfully installed structural soil mixes similar to the quality specified for a period of not less than 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Protect materials of this section before, during and after installation; objects designated to be retained; and the installed work of other trades.

- B. In the event of damage to any of these items, immediately make repairs or replacements necessary to the acceptance of the District's Representative and at no additional cost to the District.

- C. Comply with provisions of Section 015000 – TEMPORARY FACILITIES AND CONTROLS where necessary to control dust and noise on and near the work caused by operations during performance of the Work

1.6 PROJECT CONDITIONS:

- A. Site Information: Review the geotechnical report identified in Section 02 30 00 – SUBSURFACE INVESTIGATION.
 - 1. The character of the material to be excavated or used for subgrade is not necessarily as indicated.
 - 2. Ground water elevations indicated are those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

- B. Environmental Requirements:
 - 1. Comply with the project SWPPP.
 - 2. When unfavorable weather conditions necessitate interrupting filling and grading operations, prepare areas by compaction of surface and grading to avoid collection of water.
 - 3. Provide adequate temporary drainage to prevent erosion.
 - 4. After interruption, reestablish compaction specified in last layer before resuming work.
 - 5. Protect existing storm drainage system from silt and debris resulting from construction activities. If contamination occurs, remove contamination at no cost to the District.
 - 6. Protect existing streams, ditches and storm drain inlets from water-borne soil by means of straw bale dikes, filter fiber dams, or other methods.

- C. Protections of open excavations.

1. Barricade open excavations and post with warning lights.
 2. Comply with requirements of Section 01 50 00 –TEMPORARY FACILITIES AND CONTROLS.
 3. Operate warning lights as recommended by authorities having jurisdiction.
 4. Protect structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations, from damages caused by settlement, lateral movement, undermining, washout and other hazards.
- D. Protection of Subgrade
1. Protection of Subgrade: Do not allow equipment to pump or rut subgrade, stripped areas, footing excavations, or other areas prepared for project.
 2. At Contractor's option, and with the Geotechnical Engineer's approval, a working pad of granular material may be laid to protect footing and floor subgrade soils from disruption by traffic during wet conditions.
- E. Transport of soils.
1. Transport all excess soils materials by legally approved methods to disposal areas.
 2. Coordinate with the District's Representative.
 3. Sufficient topsoil and fill material shall be retained from the site to complete project requirements.
 4. Any additional topsoil and fill requirements shall be the responsibility of the Contractor.
- F. Blasting and use of explosives will not be permitted.
- G. Dust Control Requirements: At all times during earthwork operations and until final completion and acceptance of the earthwork, the Contractor shall prevent the formation of an airborne dust and dirt nuisance from interfering with the surrounding normal operations. The Contractor shall effectively stabilize the site of work in such a manner that it will confine dust particles to the immediate surface of the work and to obtain a minimum of 40 percent emissions reduction by applying a dust palliative except in areas of active cut and fill. The dust palliative shall be non-petroleum based. Water alone is not considered to be a dust palliative. The dust palliative shall be applied at the rate and method in conformance with Section 18, "Dust Palliatives," of the Caltrans Standard Specifications and as recommended and/or specified by the manufacturer. Contractor shall assume liability for all claims related to dust and dirt nuisances.
- H. All areas to receive Structural Soil shall be inspected by the District's Representative prior to beginning this work.

1.7 EXISTING UTILITIES

- A. The District will contact local utility agencies prior to construction and arrange for the shut-off of all utilities serving the buildings to be demolished. Coordinate work required to abandon active lines with the Program Manager and the District.
- B. Locate existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during excavation operations.
- C. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the District's Representative immediately for directions.
1. Cooperate with the District and public and private utility companies in keeping their respective services and facilities in operation.
 2. Repair damaged utilities to the satisfaction of the District's Representative.
- D. Do not interrupt existing utilities serving facilities occupied and used by the District or others, except when permitted in writing by the District and then only after acceptable temporary utility services have been provided.

1.8 SEQUENCING AND SCHEDULING:

- A. The schedule of operations shall be reviewed by the District's Representative prior to commencement of any work.
- B. Coordinate operations with other construction activities, such as relocation of existing utilities.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. General:
 - 1. Fill material will be subject to approval of the Geotechnical Engineer.
 - 2. For approval of imported fill material, notify the District's Representative at least 7 days in advance of intention to import material, designated proposed borrow area, and permit the Geotechnical Engineer to sample as necessary from borrow area for purpose of making acceptance tests to prove quality of material.
 - 3. The Geotechnical Engineer's report on acceptability shall be final and binding.
 - 4. During grading operations, soil types other than those analyzed in the geotechnical report for the project, may be encountered.
 - 5. Consult the Geotechnical Engineer to determine the suitability of these soils.
- B. Engineered Fill Material: Soil excavated from site (native) or imported conforming to requirements for fill material contained in geotechnical report for this project.
- C. Native Fill Requirements:
 - 1. Approved native materials shall have a particle size not exceeding 3 inches as determined by ASTM D422, at least 90 percent by weight passing the 1 inch sieve and less than 3 percent organic content by weight.
- D. Imported Fill Requirements: Imported fill, where required, shall be non expansive granular soil, free of organic matter and deleterious substances. Imported fill material shall conform to the following requirements:
 - 1. Grading:

<u>U. S. Sieve Size</u>	<u>Percentage Passing Sieve</u>
2 ½ inch	100
No. 8	25-45
No. 200	0-100
 - 2. Be thoroughly compactable without excessive voids.
 - 3. Meet the following plasticity requirements:
 - a. Maximum Plasticity Index of 12, as determined by ASTM D4318.
 - b. Maximum Liquid Limit of 35, as determined by ASTM D4318.
- E. Imported Fill for Planting Areas: Imported fill for use in planting areas shall be sandy loam weed free soil. Submit analysis from certified Soil and Plant Lab. Coordinate with Landscape Architect.
- F. Topsoil: Friable clay loam surface soil found in a depth of not less than 10 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones and other objects over 2 inches in diameter, and without weeds, roots and other objectionable material.
 - 1. Use topsoil for top 2 feet of fill against exterior walls, except at paving and sidewalks.
 - 2. Topsoil may also be used beyond the area within 5 feet of building, except under paving and sidewalks.
 - 3. Confirm suitability of stockpiled materials.
- G. Sand: Clean, well-graded fine to coarse sand with not more than 2 percent passing the #200 sieve based on wet sieve analysis. Provide at locations indicated in the construction documents.
 - 1. Where coarse sand is required, provide sand no finer than No.40 sieve.
- H. Bioretention Soil Mixture

1. Follow Appendix L of the Municipal Regional Permit
 - I. Drain Rock:
 1. Washed, uniformly graded mineral aggregate ASTM D448 with percentage composition of dry weight conforming to following limits:
 - a. Passing 1-inch Sieve: 100 percent.
 - b. Passing 3/4-inch Sieve: 90-100 percent.
 - c. Passing No. 4 Sieve: 0-10 percent.
 2. Base at Slab-on-Grade: As specified in the geotechnical report for this project.
 3. Absorption of water to saturated-surface dry condition shall not exceed 3 percent of oven-dry weight of a sample.
 - J. Backfill material for use behind retaining walls shall be a granular material consisting of sand, broken rock, or a mixture of sand and gravel containing no size larger than 2 ½ inches and not more than 15 percent passing the No. 200 sieve.
 - K. Pea Gravel: 3/8 inch to ½ inch washed, uncrushed gravel. Use at drainage pipe and at other locations indicated.
 - L. Filter Fabric: Provide filter fabrics that meet or exceed the listed minimum physical properties determined according to ASTM D4759 and the referenced standard test method in parentheses.
 1. Grab Tensile Strength (ASTM D4632): 120 lb.
 2. Apparent Opening Size (ASTM D4751): #70 U.S. Standard sieve.
 3. Permeability (ASTM D4491): 135 gallons per minute per square foot.
 - M. Drainage Pipe:
 1. Perforated corrugated plastic drainage tubing meeting ASTM F667, with continuous integral nylon filter screen.
 2. Acceptable Manufacturers and Products: Advanced Drainage Systems "DrainGuard," Hancor "Agri-Flow."
 3. Provide couplings, elbows and other fittings as recommended by pipe manufacturer.
 - N. Water: Clean and free from deleterious amounts of acids, alkalis, salts and organic matter.

2.2 SOIL STERILANT:

- A. Soil Sterilant shall be Treflan E.C. or approved equivalent.

2.3 TERMITICIDE:

- A. Termiticide shall be Permethrin, Denon, or approved equivalent.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Prior to commencement of earthwork, become thoroughly familiar with site conditions.
- B. If event discrepancies are found, immediately notify the [District's/Owner's] Representative in writing, indicating the nature and extent of differing conditions.
- C. Requirements:
 1. Grades and elevations are to be established with reference to benchmarks referenced on Drawings.
 2. Maintain engineering markers such as monuments, benchmarks and location stakes. If disturbed or destroyed, replace.

- D. No earthwork shall be performed without physical presence or acceptance of the Geotechnical Engineer.
- E. The Geotechnical Engineer's acceptance is required by these specifications; notify the District's Representative at least 48 hours prior to commencing any phase of earthwork.
 - 1. No phase of work shall proceed until prior phase has been accepted by the Geotechnical Engineer.
 - 2. Work shall not be covered up or continued until acceptance of the Geotechnical Engineer shall give written notice of conformance with the specifications upon completion of grading.
- F. Compacting:
 - 1. Compact by power tamping, rolling or combinations thereof as accepted by the Geotechnical Engineer.
 - 2. Where impractical to use rollers in close proximity to walls, stairs, etc., compact by mechanical tamping.
 - 3. Scarify and re-compact any layer not attaining compaction until required density is obtained.
 - 4. Compaction by flooding, ponding or jetting will not be permitted, unless specifically accepted by the Geotechnical Engineer.
- G. Hazardous Materials
 - 1. If any materials are encountered that may be hazardous (as defined in Section 25117 of the California Health and Safety Code), inform the [District's/Owner's] Representative verbally within 24 hours and in writing within 2 business days. Upon discovery, material is to remain undisturbed until investigation by State's representative is complete. The removal and disposal of hazardous materials, if discovered, is not part of the scope of work of this Division for this project.

3.2 SITE PREPARATION:

- A. Protect structures, utilities, sidewalks, pavements, and other facilities which are to remain from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations. Set up tree protection measures prior to commencing grading or demolition operations.
- B. Clearing and Grubbing:
 - 1. Remove from area of designated project earthwork all improvements and obstructions, including designated concrete curbs or slabs, asphaltic concrete, all tree and shrub roots, any buried utility and irrigation lines, and other matter determined by the Geotechnical Engineer to be deleterious.
 - a. In all new planting areas, remove existing base material.
 - b. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
 - 2. Remove from the site all trees and shrubs, unless otherwise indicated on the drawings as existing trees to be left standing.
 - 3. Remove or fill existing basements left from removed structures as appropriate to areas. Compact in accordance with requirements of these specifications.
 - 4. Removed material shall become property of the Contractor and shall be removed from site, unless otherwise indicated on the drawings or specified herein.
 - 5. Holes resulting from removal of underground obstructions that extend below finish grades shall be cleared and backfilled with engineered fill.
 - 6. Existing Trees to remain:
 - a. Verify the locations of existing trees to be preserved.
 - b. Replace existing trees to remain that are damaged during construction at no additional cost to the District.
 - c. Carefully make clean cuts at roots and branches of trees indicated to be left standing, where such roots and branches obstruct new construction. Paint cuts over ½ inch in size with tree pruning compound.
- C. Topsoil:

1. Strip topsoil to whatever depths encountered in manner to prevent intermingling with the underlying subsoil or other objectionable material.
2. Remove heavy growths of grass from areas before stripping. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to the main root system.
3. Stockpile topsoil in storage piles to freely drain surface water.
4. Cover storage piles if required to prevent windblown dust.

3.3 EXISTING UTILITIES:

- A. Protect existing utilities that are to remain in operation as specified.
- B. Demolish and completely remove from the site existing underground utilities indicated to be removed. See Section 311000 – SITE PREPARATION AND DEMOLITION.
- C. Movement of construction machinery and equipment over existing pipes and utilities during construction shall be at contractor's risk.
- D. Excavation made with power-driven equipment is not permitted within 2 feet of any known utility or subsurface structure.
 1. Use hand or light equipment for excavating immediately adjacent to or for excavations exposing a utility or buried structure.
 2. Start hand or light equipment excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured.
 3. Support uncovered lines or other existing work affected by excavation until approval for backfill is obtained.
 4. Report damage of utility line or subsurface structures immediately to the District's Representative.

3.4 PREPARATION OF SUBGRADE:

- A. Expansive soils are anticipated at the site.
 1. To help mitigate expansive soil problems, over-excavate and replace the upper 12 inches of building pad subgrade with properly compacted soil with a Plasticity Index of 12 or less.
 2. Review the necessity for over-excavation of expansive soils once the final excavation depth has been determined.
 3. Include a plastic vapor retarder with a 2-inch thick sand cushion placed above the vapor retarder.
 4. A layer of clean gravel or crushed rock at least 4 inches thick should underlie the vapor retarder. The crushed rock shall have 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 sieve.
- B. Scarify building pad, exterior flatwork and pavement subgrade to a depth of at least 8 inches and work until uniform and free from large clods.
 1. Bring expansive subgrades to not less than 3 percentage points above optimum moisture content (not less than 2 percentage points above optimum upper 6 inches of pavement subgrade) and compact to 90 percent of the maximum laboratory dry density, in accordance with ASTM D1557.
 2. Bring non-expansive subgrades to or slightly above the optimum moisture content and compact to 90 percent of the maximum laboratory dry density in accordance with ASTM D1557.
 3. Increase compaction of the upper 6 inches of pavement subgrades to 95 percent of the maximum laboratory dry density and at least 2 percent over the optimum moisture content per ASTM D1557 for non-expansive subgrades.

3.5 DEWATERING:

- A. Do not allow water from surface drainage or underground sources to accumulate in excavations, unfinished fills, or other low areas.

- B. Provide and maintain ample means and devices to remove water promptly and dispose properly of water entering excavations or other parts of the work to prevent softening of exposed surfaces.
- C. Dewater by methods which will ensure dry excavation and preservation of finish lines and grades of excavation bottoms.
- D. Prior to excavating below ground water level, place dewatering system in operation.
 - 1. Lower the ground water level a minimum of 1 foot below the bottom of the excavation.
 - 2. Relieve the hydrostatic pressure in pervious zones below the subgrade elevation to prevent uplift.
 - 3. Use screens and gravel packs as necessary to prevent removal of fines from the soil.
- E. Operate the dewatering system continuously, 24 hours a day, 7 days a week until construction work below existing ground water level is completed.
 - 1. Measure and record the performance of the dewatering system.
 - 2. After placement of initial slabs and backfill, the ground water level may be allowed to rise.
 - 3. At no time allow ground water to rise higher than 1 foot below the prevailing level of excavation or backfill.
 - 4. Have a back-up pump and system available for immediate use.
- F. Dispose of water away from the work in suitable manner without damage to adjacent property or menace to public health.
- G. Do not drain water into work being built or under construction without prior acceptance of the District's Representative.
- H. Protect existing storm drainage system from silt and debris resulting from construction activities. If contamination occurs, remove contamination at no cost to the District.

3.6 SITE EXCAVATION:

- A. General
 - 1. All supports, shoring, and sheet piling required for the sides of excavations or for protection of adjacent existing improvements shall be provided and maintained by the Contractor. The adequacy of such systems shall be the complete responsibility of the Contractor.
 - 2. Earth and rock, regardless of character and subsurface conditions, shall be excavated to depths shown on drawings and to the neat dimensions of the footings wherever practicable, to permit pouring of footings and grade beams without use of side forms, except at slab perimeters.
 - 3. Large rocks, pieces of concrete or other obstructions, if encountered during the excavation/scarifying operations, shall be removed and disposed of by the Contractor off the site in a legal manner.
 - 4. Where footing excavation is too deep, backfill shall be concrete. Where footings are over dug laterally, side forms shall be employed for backfill with rock fill or concrete backfill shall be used (Contractor's option).
 - 5. Where forming is required, only that excavation necessary to permit placing and removal of forms shall be done.
 - 6. Bottoms of all footings and foundations trenches shall be subject to testing by the Geotechnical Engineer. Corrective measures as directed by the State's representative shall be executed promptly.
- B. Excavate subgrade as required to allow for finish grades shown on drawings, as required for structural fill or otherwise required for proper completion of the work.
- C. Remove and replace subgrade materials designated by Geotechnical Engineer as unsuitable.

3.7 FILL AND COMPACTING:

- A. General Requirements:
 - 1. Backfill excavations as promptly as work permits.
 - 2. Do not place engineered fill or backfill until rubbish and deleterious materials have been removed and areas have been approved by the District's Representative.
 - 3. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
 - 4. In excavations, use satisfactory excavated or borrow material.
 - 5. Under grassed areas, use satisfactory excavated or borrow material.
- B. After subgrade compaction has been approved by the Geotechnical Engineer, spread the engineered fill materials in lifts not exceeding 8 inches and uniformly mixed during the spreading operation.
 - 1. Bring non-expansive fill materials to or slightly above the optimum moisture content and compact to at least 90 percent of the maximum laboratory dry density, per ASTM D1557.
 - 2. Bring non-expansive aggregate fill materials to or slightly above the optimum moisture content and compact to at least 95 percent of the maximum laboratory dry density, per ASTM D1557.
 - 3. Do not compact the top 12 inches of soil in the planting areas.
 - 4. Fill sections greater than 5 feet in depth shall be compacted to at least 95 percent relative compaction per ASTM D1557.
- C. Repeat compaction procedure until proper grade is attained.
- D. Rocks generated during site earthwork may be used in fill when conforming to material specifications.

3.8 MOISTURE CONTROL:

- A. Do not place, spread or roll fill material during unfavorable weather conditions or when fill material is excessively wet.
- B. Do not resume operations until moisture content and fill density are satisfactory to the Geotechnical Engineer.
- C. Provide berms or channels to prevent surface water from flooding excavations. Promptly remove water collecting in depressions.
- D. Where soil has been softened or eroded by flooding or by placement during unfavorable weather, remove damaged areas and re-compact as described for fill and compaction.
- E. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material.
 - 1. Prevent free water appearing on surface during or subsequent to compaction operation.
 - 2. Remove and replace, or scarify and air dry, soil material too wet to permit compaction to specified density.
 - 3. Soil material removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.9 GRADING:

- A. General: Uniformly grade areas of work including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
 - 1. All areas covered by the project, including excavated and filled areas and adjacent transition areas, shall be uniformly graded so that finished surfaces are at the elevations established by the plans. Planter areas to receive future topsoil shall be graded below finished grade to allow for such material.
 - 2. Finished surfaces and surfaces to receive paving and aggregate base shall be smooth, compacted, and free from irregular surface drainage.

3. Ditches, gutters, and swales shall be finished to permit proper surface drainage.
 4. All surface areas, except paved and sloped embankments exceeding 8:1, shall be hydroseeded in accordance with specifications in Landscaping Sections.
- B. Grading Tolerances:
1. Excavations shall not exceed 0.10-foot variation from dimensions and elevations shown or noted, unless otherwise approved by the District's Representative.
 2. Fill and backfill shall be placed with tolerance of plus or minus 0.10 foot if placed in layers.
 3. Grading shall be done within plus or minus 0.10 foot typically; areas under slabs, walks or pavements shall be graded within tolerance of 0 to 0.10 foot.
 4. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
 5. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
 6. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than ½ inch above or below required subgrade elevation.
- C. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.10 SOIL STERILIZATION:

- A. General: Soil sterilant shall be applied to prepared subgrade or after installation of rock or aggregate base as recommended by the manufacturer. Sterilant shall be applied uniformly at the rate recommended by the manufacturer to all areas beneath asphalt concrete pavement, brick pavement, concrete pavement, or on-grade concrete slabs including sidewalks, curbs, and gutters and areas between the inner and outer security fences. In addition to ground areas treated, sterilant shall be applied below expansion or control joints, and at all areas where pipe, ducts, or other features penetrate slabs.

3.11 BIORETENTION SOIL MIXTURE

- A. General: Soil material installed in bio-retention and bio-swales shall be tested in-site to verify the field conditions meet performance requirements.
- B. Installation: Place soil material in lifts not exceeding 8-inches. Compact to between 83 and 87 percent relative compaction.
- C. Testing: Demonstrate in-site percolation by the following method. One test shall be performed for each treatment measure.
1. Drive a 1 foot diameter pipe 2.5 feet long into the treatment soil until the end is 6 inches above the under drainage (typically 12-inches down).
 2. Wet treatment zone then fill pipe with water to 12 inches above ground elevation.
 3. Pipe should empty 12 inches of water within the following time periods:

<u>Soil Type</u>	<u>Min</u>	<u>Max</u>
Dewatering	1hr 12 min	6hrs
Treatment	1hr 12 min	2hrs 24min
 4. If the in-situ test fails the soil within the treatment measures shall be removed and re-instated.

3.12 DISPOSAL OF EXCESS AND WASTE MATERIALS:

- A. Removal of Excess Excavated Material: Excess material shall be removed by the Contractor off the site in a legal manner.

3.13 FIELD QUALITY CONTROL:

- A. Testing Agency Services: Allow testing agency to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.
 - 1. Perform field in-place density tests according to ASTM D1556 (sand cone method), ASTM D2167 (Rubber Balloon Method), or ASTM D2937 (Drive Cylinder Method), as applicable.
 - a. Field in-place density tests may also be performed by the nuclear method according to ASTM D6938 , provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D1556. With each density calibration check, check the calibration curves furnished with the moisture gauges according to ASTM D6938
 - b. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gauges at beginning of work on each different type of material encountered, and at intervals as directed by the Architect.
 - 2. Footing Subgrade: At footing subgrades, use a hand probe and consult with the Geotechnical Engineer.
 - 3. Paved and Building Slab Areas; At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2,000 square feet or less of paved area or building slab, but in no case fewer than three tests.
 - 4. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 100 feet or less of wall length, but no fewer than two tests along a wall face.
 - 5. Trench Backfill: In each compacted initial and final backfill layer, perform at least one filed in-place density test for each 150 feet or less of trench, but not fewer than two tests.
- B. Number and location of test shall be at option of the Geotechnical Engineer.
- C. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, re-compact and retest until required density is obtained.
- D. After grading is completed and the testing agency has completed observation of the work, permit no further excavation or filling, except as approved by the District's Representative.

3.14 PROTECTION:

- A. Protect newly graded areas from traffic and erosion. In unpaved areas without landscaping, cover with straw erosion control blanket. Follow manufacturer's recommendations for installation. Provide and place straw wattles or biodegradable fiber logs across the slope at the midpoint and along the downhill edge of site. No soil is to be left uncovered at the completion of construction. Keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Where completed compacted areas are disturbed by subsequent construction operation or adverse weather, scarify surface, reshape, compact to required density and provide other corrective work, including retesting, prior to further construction.

3.15 CLEAN-UP:

- A. Comply with requirements of Section 017400 – CLEANING.

3.16 TERMITICIDE:

- A. Termiticide shall be applied to soils as recommended by the manufacturer. Termiticide shall be applied uniformly at the rate recommended by the manufacturer to all areas beneath and around wood frame structures.

END OF SECTION

SECTION 312300 - STRUCTURAL EXCAVATION AND FILL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Available Information: “Geotechnical Evaluation and Geologic Hazards Assessment, Las Positas College – STEAM Building, 3000 Campus Hill Drive, Livermore, CA”, dated November 22, 2023, by Ninyo & Moore, is available in accordance with “Information Available to Bidders”.

1.2 SUMMARY

- A. This Section Includes:
 - 1. Excavation for foundations and pits.
 - 2. Backfilling structural excavations as required.
 - 3. Fill over concrete mat foundations.
- B. Related Sections:
 - 1. Division 03 Section “Concrete Formwork” for formwork for footings.
 - 2. Division 31 Section “Earthwork” for mass excavation and/or fill for building pad.

1.3 REFERENCES

- A. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where cited in this Section.
- B. American Concrete Institute (ACI):
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings, 2010.
 - 2. ACI 229R – Controlled Low Strength Materials, 2013.
- C. California Department of Transportation’s (Caltrans):
 - 1. CSS - Standard Specifications, 2010.

1.4 SITE CONDITIONS

- A. Notify Owner’s Representative when site conditions differ from findings of Geotechnical Investigation Report.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Concrete: Concrete materials and proportions shall be in accordance with ACI 301 to produce concrete with minimum compressive strength of 2500 psi at 28 days.
- B. Structural Fill: CSS Section 26, Class 2 Aggregate Base rock, 3/4” size.
- C. Controlled Low Strength Material: Machine mixed, self-compacting, low-strength fill consisting of fine aggregate, cementitious materials, entrained air and water. Mix and mixing shall conform to recommendations of ACI 229 to achieve the following properties:

1. Slump: 8 to 10 inches.
 2. Compressive Strength:
 - a. For backfill: Minimum 150 psi to maximum 300 psi at 30 days.
 - b. For fill beneath footings: Minimum 300 psi at 30 days.
 3. Fresh Density: 115 to 145 pounds per cubic.
 4. Subsidence: Minimal; a maximum of 1/16" per foot of thickness.
- D. Pea Gravel: ASTM C 33, Size No 7.
1. Fill material (over mat foundation): Crushed rock of uniform gradation, 100% passing 3/4 inch sieve.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Take measures to prevent surface water from entering excavations.
- B. Notify Geotechnical Engineer at least 48 hours prior to commencing and upon completion of excavations.

3.2 EXCAVATION

- A. Accurately cut foundation excavations to dimensions and elevations shown on Drawings to tolerances of ACI 301.
- B. Where sides are unstable or excavations are not accurately cut, over-excavate to permit placement and removal of formwork.
- C. Shore and brace excavations as required to prevent caving and danger to persons and structures. Comply with applicable safety regulations.
- D. Prepare bottoms of footing excavations to produce conditions acceptable to Owner's Representative, based on professional opinion of Geotechnical Engineer.
 1. The bottoms of excavations shall be firm, undisturbed earth, clean and free from loose material, debris and foreign matter.
 2. Remove or recompact disturbed material.
 3. Remove soft or unstable material to a depth satisfactory to Geotechnical Engineer.
 4. Fill over-depth excavations with concrete, flowable fill, or structural fill compacted to minimum 95% relative compaction.
- E. Maintain footing conditions approved by Geotechnical Engineer until concrete work is complete.
 1. In periods of wet weather, over-excavate footings and place 2-inches minimum concrete mud-slab as soon as practical after completing excavation.
- F. Keep excavations free of water at all times until foundation concrete is cast.
- G. Stockpile or remove excavated material from site in accordance with Division 31 Section "Earthwork".

3.3 BACKFILLING

- A. Place and compact structural fill in accordance with Division 31 Section, "Earthwork".
 1. Use controlled low strength material or pea gravel for backfill against sides of footings and pits, where adequate compaction of structural fill cannot be achieved.
 - a. Controlled low strength material may be used in lieu of structural fill at all locations.

- b. Pea gravel may be used in widths no greater than twelve inches.
 - 1) Pea gravel may not be used where structural fill could otherwise be used.
 - 2) Pea gravel may not be used to back fill utility trenches underneath the building.
- B. Backfill footings after formwork is removed. Do not backfill pits until concrete has cured a minimum of 7 days.

3.4 FILL OVER CONCRETE MAT FOUNDATIONS

- A. Preparation:
 - 1. Verify piping is securely supported against vertical and lateral displacement.
 - 2. Where area is not enclosed prior to placement of fill, make provision for removal of water.
- B. Placement: Fill may be placed to the full specified thickness without compaction.
 - 1. Pipes: Bed pipes in fill up to grade of underside of pipe, taking care not to place material atop pipe. Shovel slice material under and beside the pipe up to the spring line without moving the pipe.
- C. Consolidation: Immediately prior to placement of vapor retarder, consolidate surface with a minimum of 3 passes of a vibratory plate. Achieve specified grade to plus 0 inch to minus 1-1/2 inch tolerance.

3.5 FIELD QUALITY CONTROL

- A. The Geotechnical Engineer will observe footing excavations prior to placement of reinforcement; and again, immediately prior to casting of concrete.
- B. The Geotechnical Engineer will observe the placement of fill and backfill material.

END OF SECTION

SECTION 32 12 33 - PAVING AND SURFACING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes (but is not necessarily limited to):
 - 1. Asphalt Concrete Paving.
 - 2. Portland Cement Concrete Paving.
 - 3. Liquid Asphalt and Asphalt Emulsion.
 - 4. Aggregate Base.
 - 5. Concrete Pavers.
 - 6. Decomposed Granite.
 - 7. Sealants

- B. Related work furnished under other sections but conforming to the provisions of this section:
 - 1. Subgrade preparation.
 - 2. Aggregate Base installation.

- C. Related Sections:
 - 1. Section 31 10 00 – SITE PREPARATION AND DEMOLITION.
 - 2. Section 31 22 00 – EARTHWORK AND GRADING.
 - 3. Section 32 17 23 – PAVEMENT MARKING.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. A615: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 2. C150: Portland Cement.
 - 3. D1557: Moisture Unit Weight Relations of Soils and Aggregate Mixtures Using a 10 lb (4.5 kg) Rammer and 18 in. (457 mm) Drop.
 - 4. D1682: Breaking Loads and Elongation of Textile Fabrics.

- B. California Code of Regulations (CCR): Title 24, Chapter 2-71, Site Development Requirements for ADA Accessibility.

- C. California Department of Transportation (Caltrans):
 - 1. Standard Specifications:
 - a. Section 20-10: Decomposed Granite.
 - b. Section 24: Stabilized Soils.
 - c. Section 26: Aggregate Bases.
 - d. Section 37: Bituminous Seals.
 - e. Section 39: Asphalt Concrete.
 - f. Section 40: Concrete Pavement.
 - g. Section 41: Concrete Pavement Repair.
 - h. Section 51: Concrete Structures.
 - i. Section 52: Reinforcement.
 - j. Section 73: Concrete Curbs and Sidewalks.
 - k. Section 88: Geosynthetics.
 - l. Section 90: Portland Cement Concrete.
 - m. Section 92: Asphalts.
 - n. Section 93: Liquid Asphalts.
 - o. Section 94: Asphaltic Emulsions.
 - p. Section 95: Epoxy
 - 2. Traffic Manual.
 - 3. Highway Design.

- D. Institute of Transportation Engineers: Transportation and Traffic Engineering Handbook.

- E. American Concrete Institute Manual of Practice.
- F. Interlocking Concrete Pavement Institute (ICPI).

1.3 SUBMITTALS

- A. Requirements: Refer to Section 01 33 00 – SUBMITTAL PROCEDURES.
- B. Asphalt Concrete Paving:
 - 1. Provide copies of material certificates signed by the material producer and the Contractor, certifying that each material item complies with or exceeds specified requirements.
 - 2. The Contractor shall furnish a certified weight or load slip for each load of material used in the construction of the asphalt concrete pavement.
- C. Concrete Paving: The Contractor shall furnish mill test reports on the cement, reinforcement bars, and aggregates, showing compliance with the respective specifications. The Testing Engineer may make concrete test cylinders and slump tests as deemed necessary to determine compliance with the Specifications.
- D. Liquid Asphalt.
- E. Pavement Reinforcement Fabric.
- F. Tack Coat.
- G. Pavement Reinforcement Mesh.
- H. Structural Geotextile Fabric.
- I. Concrete Pavers.
- J. Slurry Seal.
- K. Joint Sealants.
- L. Backer Rod.
- M. Joint Filler.
- N. Epoxy Crack Filler.
- O. Bonding Epoxy.
- P. Concrete Quality Control Plan. Inclusive of the following:
 - Placing and timing of joints including a location plan for all joints
 - Bar placement, alignment
 - Concrete placement methods
 - Finishing and curing methods and timing.
 - Joint sealants and timing of placement

1.4 PROJECT CONDITIONS

- A. Liquid Asphalt and Asphalt Emulsion:
 - 1. Seal coat and paint binder shall be applied only when the ambient temperature is above 50° Fahrenheit and when temperature has not been below 35° Fahrenheit for 12 hours immediately prior to application.

2. Fog coat, seal coat, and paint binder shall not be applied when base or surfaces are wet or contain excess moisture.
- B. Asphalt Concrete Paving: Asphalt concrete surfaces shall be constructed only when ambient temperature is above 50° Fahrenheit and when base is dry.
- C. Portland Cement Concrete: Concrete shall be placed when the conditions will yield satisfactory results and when the ambient temperature will be above 40°F for 72 hours after placement with no threat of precipitation.
- D. Joint Sealants: Sealants shall be placed per the manufacturers recommendations and when temperature is above 40°F for 2 days after and no threat of precipitation.

PART 2 - PRODUCTS

2.1 PAVING MATERIALS

- A. Aggregate Base: Aggregate base shall conform to Caltrans Class 2 (R value 78 min) aggregate base, 3/4" maximum size, as specified in Section 26 of the Caltrans Standard Specifications.
- B. Asphalt Concrete Paving:
 1. Shall be Type A HMA, conforming to Section 39-2.02B of the Caltrans Standard Specifications.
 2. Asphalt binder to be mixed with aggregate shall be performance-graded asphalt, PG64-10, conforming to Section 92 of the Caltrans Standard Specifications.
 3. Aggregate size shall be as follows:

Total AC Thickness	Min # of AC lifts	Aggregate Grading
3/4 inch - 1 1/2 inch	1	1/2" max
2 inch - 2 1/2 inch	1	1/2" max
3 inch or greater	2	1/2" max for top lift and 3/4" max for initial lifts
 4. If multiple lifts, apply a tack coat before placing a subsequent lift.
 5. Asphaltic emulsion for paint binder, fog coat, and seal coat shall be emulsified asphalt, Type SS-1h, conforming to Section 94 of the Caltrans Standard Specifications
- C. Portland Cement Concrete:
 1. Concrete shall be minor concrete conforming to Section 90-2 of the Caltrans Standard Specifications, except as modified by these specifications.
 2. Concrete Pavement shall contain a minimum of 505 lbs/yard of cementitious material.
 3. Cement shall be a combination of Type II or Type V Portland cement and supplemental cementitious materials conforming to Section 90-1.02B of the Caltrans Standard Specifications.
 4. For minor concrete, the maximum aggregate size must not be larger than 1-1/2 inches or smaller than 3/4 inch, per Section 90-2.02C of the Caltrans Standard Specifications.
 5. Water shall be potable and free of organic matter and injurious amounts of oil, acid, alkali, or other deleterious substances.
 6. Unless otherwise noted on the plans the concrete mix design shall provide a minimum compressive strength of 3,000 psi at 28 days.
 7. Supplementary Cementitious Materials (SCM) shall comply with Section 90-1.02B(3) of the Caltrans Standard Specifications including chemical properties, physical properties, and proportioning.
 8. Reinforcing bars shall be deformed and shall conform to ASTM A615.
 9. Filled joints, unless noted otherwise on the Drawings, shall be 1/4-inch wide, the full depth of the concrete section and conforming to Section 51 of the Caltrans Standard Specifications.
 10. Joint filler shall conform to Section 51 of the Caltrans Standard Specifications for pre-molded expansion joint filler and expanded polystyrene joint filler.
 11. No admixtures will be allowed without prior approval of the Engineer of Record.
- D. Epoxy shall meet the requirements of Section 95 of the Caltrans Standard Specifications.

1. Epoxy used to bond dowels to hardened concrete shall be Type 1, Grade 1, Class B or C per ASTM C881.
 2. For high strength applications epoxy shall be Type IV.
- E. Decomposed Granite:PA
1. Decomposed Granite shall conform to Section 20-5.03D of the Caltrans Standard Specifications.
 2. Soil Sterilant shall be oxadiazone granular preemergent complying with Caltrans Standard Specification Section 20-5.03A(2).
 3. Edging shall comply with Caltrans Standard Specification Section 20-5.02.
 4. Crushed granite rock gradation shall comply with Caltrans Specification Section 20-5.03D(2).
 5. Solidifying Emulsion shall be either a water-based polymer or non-toxic organic powdered binder specifically manufactured to harden decomposed granite. The solidifying emulsion shall not alter the decomposed granite color.
- F. Pavement Reinforcement Fabric: Pavement reinforcement fabric shall meet Caltrans Section 96-1.02J. BP Petromat, or approved equivalent.
- G. Crack Sealant:
1. Crack sealant shall be rubberized hot-pour type and shall meet ASTM D 3405. Husky 1611, or approved equivalent.
 2. Blotting Agent shall be one of: Screened sand, cement, or fly ash.
- H. Tack coat: Tack coat shall meet Caltrans Section 39-2.01B(10).
- I. Pavement reinforcement mesh: Pavement reinforcement mesh for use in overlays shall be Glasgrid Model 8501, or approved equivalent.
- J. Structural geotextile fabric: Structural geotextile fabric shall be Mirafi 500X, or approved equivalent.
- K. Joint Sealant:
1. Dow Corning 890-SL or approved silicone sealant conforming to ASTM D5893, C639, C1183, C679, C792, C66 and C792.
 2. Conform to Caltrans Section 41-5.02B.
- L. Backer Rod
1. Backer Rod shall be expanded, cross-linked, crossed-cell polyethylene foam conforming to ASTM D5249, Type I.
 2. Rod diameter shall be 25% greater than the saw cut joint width

2.2 BITUMINOUS SEALS

- A. Fog Seal: Fog Seal asphaltic emulsion shall conform to Caltrans Section 37-4.02.
- B. Flush Coat: Flush Coat asphaltic emulsion shall conform to Caltrans Section 37-4.03. Sand for the flush coat shall comply with the fine aggregate grading in Caltrans Section 90-1.02C(3), sand must be free of organic material or clays.
- C. Slurry Seal: Slurry seal shall conform to Caltrans Section 37-3.02B, and be Type II unless otherwise specified.
- D. Chip Seal: Chip seal shall conform to Caltrans Section 37-2 for polymer modified asphaltic emulsion seal coat and included screenings per Caltrans Section 37-2.01B.
- E. Crack Sealant: Crack Sealant shall conform to Caltrans Section 37-6.02, Type 2, unless otherwise specified.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Subgrade and Aggregate Base:
 - 1. Prepare subgrade and over excavate per Section 31 22 00 –EARTHWORK AND GRADING.
 - 2. Aggregate base shall be compacted to 95 percent ASTM D1557. Section 26-1.03E of the Caltrans Standard Specifications shall apply.
 - 3. Soil sterilant shall be applied to prepared subgrade or after installation of rock or aggregate base uniformly at the rate recommended by the manufacturer.

- B. Crack Sealing:
 - 1. Before sealing, cracks shall be cleared of dirt, dust, and all other deleterious materials to a depth of 1/4-inch to 1/2-inch.
 - 4. Cracks 1/8-inch in width and greater shall be sealed.
 - 5. Application of crack sealer shall be in accordance with the manufacturer's recommendations unless otherwise directed.

3.2 ASPHALT CONCRETE PAVING

- A. General:
 - 1. Asphalt concrete shall be proportioned, mixed, placed, spread, and compacted in conformance with Section 39 of the Caltrans Standard Specifications.
 - 2. Before placing asphalt concrete, an asphalt emulsion tack coat shall be applied to all vertical surfaces of existing pavement, curbs, gutters, construction joints, and all existing pavement to be surfaced, in conformance with Section 39 of the Caltrans Standard Specifications.
 - 3. Spreading and compacting asphalt concrete shall be performed in accordance with Section 39 of the Caltrans Standard Specifications.
 - 4. Fog seal shall be applied to all finished surfaces of asphalt concrete pavement at a rate of 0.05 gallons per square yard, in accordance with Section 37 of the Caltrans Standard Specifications.
 - 5. After fog seal has been applied, ample time shall be allowed for drying before traffic is allowed on the pavement or paint striping is applied.

3.3 CONCRETE CONSTRUCTION

- A. General:
 - 1. All concrete shall be mixed in accordance with applicable provisions of Section 90 of the Caltrans Standard Specifications.
 - 2. Construction of concrete substructures shall conform to applicable provisions of Section 51 of the Caltrans Standard Specifications. Unless noted otherwise in the Specifications, all exposed surfaces of structure shall have Class 1 surface finish. Finish shall match adjacent existing concrete paving.
 - 3. Schedule of Locations for Concrete Finish Types, unless otherwise specified:
 - a. Slabs or Stairs to receive toppings and fills: Scratched.
 - b. Exposed Stairs Fills: Nonslip.
 - c. Exterior Paved Areas: Light Broomed.
 - d. Formed Surface to receive paint: Smooth Formed.
 - e. Concealed Concrete Surfaces: Rough Formed.
 - 4. Curing shall conform to provision of Caltrans Section 90-1.03B. No pigment shall be used in curing compounds for construction of concrete curbs, gutters, and structures.
 - 5. All work shall be subject to field inspection. No concrete shall be placed until the Program Manager has approved the forms and reinforcement.
 - 6. Expansion joints on curbs and gutters shall be placed 20 feet on centers, adjacent to structures, and at all returns, and shall be filled with joint filler. Control joints shall be formed 10 feet on centers.
 - 7. Concrete shall not be dropped freely where reinforcing bars will cause segregation, nor shall it be dropped freely more than 6 feet. Spouts, elephant trunks, or other approved means shall be used to prevent segregation.

- B. Vehicular Concrete Pavement
 1. All vehicular concrete pavement shall meet the requirements of Section 40 of the Caltrans Standard Specifications.
 2. Contraction Joints shall be a minimum 1/3 of the pavement thickness.
 3. Joints shall be no less than 5 feet apart and no greater than 15 feet apart.
 4. Joints shall make rectangular panels generally square but in no case shall the dimensional ratio exceed 1.5 to 1.
 5. Timing of the joint placement is critical. Sawcut Joints must be placed as soon as the concrete can support the sawing equipment and must be completed prior to the start of volunteer cracking. The contractor is responsible for the timing of joint placement. Typical sawcut joints would be expected to be placed 4-12 hours after concrete placement.

3.4 DECOMPOSED GRANITE

- A. Compact subgrade below decomposed granite to 90% relative compaction.
- B. Sterilize soil with oxadiazon after compaction. Apply at max label rate. Apply sterilant no more than 12" outside of DG area. Soil sterilant application and DG placement shall take place during the same work day.
- C. Aggregate Base shall be spread and compacted as specified under Section 26-1.03D and Section 26-1.03E of the Caltrans Standard Specifications.
- D. Filter Fabric: Surfaces to receive filter fabric shall be free of loose or extraneous material and sharp objects that may damage filter fabric during installation.
 1. Align fabric and place in a wrinkle-free manner.
 2. Overlap adjacent fabric rolls 12 to 18 inches. Rolls shall be spread in same direction: fabric shall be fastened with staples to prevent movement of fabric during placement of decomposed granite.
 3. Filter fabric damaged during placement of decomposed granite shall be repaired or replaced to meet the fabric overlap requirements.
- E. Placement
 1. Decomposed granite shall not be placed during rainy conditions
 2. Solidifying emulsion shall be mixed thoroughly and uniformly throughout the decomposed granite per the manufacturer's instructions.

3.5 BITUMINOUS SEALS

- A. General:
 1. Mixing, spreading and placing shall be in accordance with applicable provisions of Section 37 of the Caltrans Standard Specifications.

3.6 SEALANTS AND BACKER ROD

- A. General: Where indicated on the plans and/or specifications, Contractor shall seal joints with a sealant and backer rod.
 1. Width and depth of joints shall meet project requirements and accommodate sealant and backer rod in conformance with Manufactures requirements.
 2. Placements and shall conform to Manufactures requirements.

3.7 FIELD QUALITY CONTROL

- A. Asphalt Concrete Paving:
 1. Contractor shall perform a flood test in the presence of the engineer and/or District's Representative. Location of ponding greater than 1/8" in depth may impact proper drainage and shall be marked and remedied by the contractor.

2. The specified thickness of the finished pavement shown on the plans and specifications shall be the minimum acceptable.
3. Conforms shall form a smooth, pond-free transition between existing and new pavement.
4. Depressions in paving between high spots are not to exceed 1/8-inch when measured below a 10-foot long straight-edge placed anywhere on surface in any direction.
5. The finished asphalt pavement shall have positive drainage without ponding.

3.8 CLEANUP

- A. General:
1. Surplus material remaining upon completion of paving operations shall become the property of the Contractor, to be removed from the work site and disposed of in a lawful manner.
 2. Surfaces shall be left in a clean, neat, and workmanlike condition, and all construction waste, rubbish, and debris shall be removed from the work site and disposed of in a lawful manner.

END OF SECTION

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes concrete paving[.][**including the following:**]
1. Driveways.
 2. Roadways.
 3. Parking lots.
 4. Curbs and gutters.
 5. Walks.
- B. Related Documents:
1. The basis for designing concrete mixtures and demonstrating compliance with carbon budget targets shall be in accordance with:
 - a. National Ready Mixed Concrete Association (NRMCA) Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Manufactured by NRMCA Members – Version 3 (or later).
 - b. National Ready Mixed Concrete Association, NRMCA Member Industry Average EPD for Ready Mixed Concrete – Version 3 (or later).
- C. Embodied Carbon Goals:
1. This project has a goal of reducing the embodied carbon footprint relative to a benchmark established the NRCMA Cradle-to-Gate Life Cycle Assessment Version 3 (or later). The target maximum Global Warming Potential (GWP) and target for maximum portland cement content is provided in PART 2 PRODUCTS. The target carbon footprint reduction for concrete is a weighted average by volume. It shall be permitted to propose the use of innovative products and manufacturing processes for approval by the Engineer of Record. Proposed alternatives shall meet all performance criteria for strength, durability, and constructability, and achieve the required reduction in carbon footprint.
 2. CO2 mineralized concrete is permitted where available, pending concrete performance criteria is met.

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.
- C. Embodied Carbon Footprint: embodied carbon is the carbon dioxide equivalent (CO₂e) footprint of a building or infrastructure project before it becomes operational. Embodied carbon is distinct from operational carbon – data the carbon that comes from energy, heat, lighting, etc. Embodied carbon is generally expressed as Global Warming Potential. Typically, the embodied carbon is the initial embodied carbon which only accounts for the cradle to gate impacts.
- D. Global Warming Potential: Global warming potential (GWP) is the heat absorbed by any greenhouse gas in the atmosphere, as a multiple of the heat that would be absorbed by the same mass of carbon dioxide. GWP is 1 for CO₂. For other gases it depends on the gas and the time frame. GWP for concrete is expressed in kg of CO₂e per unit of concrete (cubic yard or cubic meter).

- E. Environmental Product Declaration: An Environmental Product Declaration (EPD) quantifies environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function. EPDs are conducted in accordance with a Product Category Rule for the specific product being evaluated. (International Organization for Standardization 14025 as a Type III declaration).
- F. Product Category Rule: Product Category Rules (PCR) are a set of rules, requirements, and guidelines for developing Environmental Product Declarations (EPD) for one or more product categories. The PCR for concrete is published by NSF International.
- G. Life Cycle Assessment: Life cycle assessment (LCA) is a methodology for assessing environmental impacts associated with all the stages of the life cycle of a commercial product, process, or service.
- H. Carbon Dioxide Mineralization: Active carbonation treatment of concrete during mixing such that the carbon dioxide (CO₂) that is injected during mixing is mineralized (I.E.chemically converted into a mineral) within the concrete. The concrete may undergo mix optimization whereby the strength enhancement property of the mineralized CO₂ is utilized to adjust cementitious content, pending that the optimized concrete mix meets concrete performance requirements as outlined.
- I. Carbonization Treatment: Active introduction of CO₂ into the concrete pore fluid which reacts with calcium from calcium hydroxide and calcium silicate hydrate to form calcite (CaCO₃).

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and concrete paving construction practices.
 - c. Curing procedures.
 - d. Cold and hot weather concreting procedures.
 - e. Global warming potential (GWP) limits.
 - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete paving Subcontractor.
 - e. Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Embodied Carbon Footprint Submittals:
 - 1. Plant specific Environmental Product Declaration (EPD) for each concrete mixture proposed for the project accompanying each concrete mixture submittal.

- a. It shall be permitted to substitute plant-specific EPDs with those listed in NRMCA Member Industry Average EPD for Ready Mixed Concrete if the proposed mixtures are similar to those listed and the concrete producer participated in providing data for the NRMCA Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete.
 2. Plant specific Environmental Product Declaration (EPD) for each steel and fiber reinforcement product proposed for the project.
 3. A calculation showing that the Global Warming Potential (GWP) of all the concrete and reinforcing materials supplied for the project considered as a weighted average by volume shall be lower than the GWP target set in Section 2.
- D. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- E. Other Action Submittals:
1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For the following, from manufacturer:
1. Cementitious materials.
 2. Steel reinforcement and reinforcement accessories.
 3. Fiber reinforcement.
 4. Admixtures.
 5. Curing compounds.
 6. Applied finish materials.
 7. Bonding agent or epoxy adhesive.
 8. Joint fillers.
- B. Material Test Reports: For each of the following:
1. Aggregates: [**Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.**]
- C. Field quality-control reports.
- D. Product Test Reports and Certificates: For each of the following, signed by manufacturers:
1. Carbon dioxide mineralization: Provide concrete producers certificate verifying mineralization of carbon dioxide. Include quantity, location, and supplier of injected CO2.

1.6 QUALITY ASSURANCE

- A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
- C. Documentation that the concrete supplier participated in supplying data to the NRMCA Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

- D. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Recycled content not less than 90 percent, Provide documentation indicating postconsumer and preconsumer recycled content.
- B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.
- C. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
- D. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.
- E. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.

- F. Plain-Steel Wire: ASTM A1064/A1064M, as drawn.
- G. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, plain.
- H. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- I. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 plain-steel bars.
- J. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- K. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

2.3 CONCRETE MATERIALS

- A. Cementitious Materials: Materials conforming to the following are permitted:
 - 1. Portland Cement: ASTM C150/C150M, gray portland cement Type I/II.
 - 2. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag Type IP, portland-pozzolan Type IL, Portland-limestone Type IT, ternary blended cement, excluding:
 - a. Type IS (70) and Type IT (70).
 - 3. Hydraulic cement: ASTM C1157/C1157M.
 - 4. Fly ash or natural pozzolan: ASTM C618, Class C or Class F.
 - 5. Slag cement: ASTM C989/C989M, Grade 100 or 120.
 - 6. Silica fume: ASTM C1240/C1240M.
 - 7. Ground glass pozzolan: ASTM C1866/C1866M.
- B. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: Complying with ASTM C1602.
- D. Air-Entraining Admixture: ASTM C260/C260M.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

- F. Carbon Dioxide Mineralization: ASTM C494 Type S. Carbon dioxide in the mixture must be post-industrial.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D1752, cork or self-expanding cork or ASTM D8139, semirigid, closed-cell polypropylene foam in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

2.6 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.
- B. Drying shrinkage limit is percentage in change in length after 28 days of drying when tested as per ASTM C157 with 3 inches x 3 inches x 11 inches specimen moist cured 7 days prior to drying.

- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content, 3/4-inch Nominal Maximum Aggregate Size: 6 percent plus or minus 1-1/2 percent.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture high-range, water-reducing admixture high-range, water-reducing and retarding admixture plasticizing and retarding admixture in concrete as required for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (56 Days): 4000 psi.
 - 2. Maximum W/C Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch.
 - 4. Shrinkage Limit: 0.04 percent.
- G. Global Warming Potential (GWP) or portland cement content shall be [20%][30%][40%] lower than the baselines established below.
 - 1. Baselines for 4000 psi
 - a. GWP: 236 kg CO₂e/cubic yard
 - b. Cement Content: 475 pounds / cubic yard
 - 2. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. Furnish batch certificates for each batch discharged and used in the Work.
 - 3. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.
- F. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - 2. Provide tie bars at sides of paving strips where indicated.
 - 3. Butt Joints: Use **[bonding agent] [epoxy-bonding adhesive]** at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of [50 feet] unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.

3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows[, **to match jointing of existing adjacent concrete paving**]:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a [1/4-inch] [3/8-inch] radius. Repeat grooving of contraction joints after applying surface finishes. [**Eliminate grooving-tool marks on concrete surfaces.**]
 - a. Tolerance: Ensure that grooved joints are within [3 inches] either way from centers of dowels.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 - a. Tolerance: Ensure that sawed joints are within [3 inches] either way from centers of dowels.
 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a [1/4-inch] [3/8-inch] radius. Repeat tooling of edges after applying surface finishes. [**Eliminate edging-tool marks on concrete surfaces.**]

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.
- H. Screed paving surface with a straightedge and strike off.

- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 - 2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
 - 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

- A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
 - 1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
 - 2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
 - 3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
 - 4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch.
 - 1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
 - 2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
 - 3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
 - 4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread [25 lb/100 sq. ft.] [40 lb/100 sq. ft.] [60 lb/100 sq. ft.] of dampened, slip-resistant aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
2. Uniformly distribute approximately two-thirds of slip-resistant aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistant aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
3. Cure concrete with curing compound recommended by slip-resistant aggregate manufacturer. Apply curing compound immediately after final finishing.
4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

3.9 INSTALLATION OF DETECTABLE WARNINGS

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 321726 "Tactile Warning Surfacing."
 1. Tolerance for Opening Size: **[Plus 1/4 inch, no minus]**.
- B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.
- C. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
 1. Before using stamp mats, verify that the vent holes are unobstructed.
 2. Apply liquid release agent to the concrete surface and the stamp mat.
 3. Stamping: **[While initially finished concrete is plastic] [After application and final floating of pigmented mineral dry-shake hardener]**, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
 4. Trimming: After **[24]** hours, cut off the tips of mortar formed by the vent holes.
 5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.10 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing moisture-retaining-cover curing curing compound as follows:
 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

- a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.11 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 1. Elevation: 3/4 inch.
 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 3. Surface: Gap below 10-feet- long; unleveled straightedge not to exceed 1/2 inch.
 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
 5. Lateral Alignment and Spacing of Dowels: 1 inch.
 6. Vertical Alignment of Dowels: 1/4 inch.
 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
 8. Joint Spacing: 3 inches.
 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
 10. Joint Width: Plus 1/8 inch, no minus.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will be performed according to the following requirements:
 1. Testing Frequency: Obtain at least one composite sample for each [100 cu. yd.] [5000 sq. ft.] or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results to be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 324020 - LANDSCAPE METALWORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide all labor, materials and equipment as required for complete, finished installation of metalwork as shown on the drawings and specified including the following items:
 - 1. Railing for non-architectural site ramps and stairs
 - 2. Miscellaneous landscape metal
- B. Metal fabrication includes plates, bars, strips, tubes, pipes and castings made from iron and steel that are not specifically listed herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 321313 "Site Concrete"
- B. Section 329000 "Planting"

1.3 REFERENCES AND STANDARDS

- A. "Code for Arc and Gas Welding in Building Construction" of American Welding Society, AWS D1.1, latest edition, with current supplements and addenda, is hereby made a part of this Section and miscellaneous metalwork shall conform to the applicable requirements therein, except as otherwise specified herein or shown on the drawings. Nothing contained herein shall be construed as permitting work that is contrary to code requirements or governing rules and regulations.
- B. All work shall conform to the American Institute of Steel Construction Specifications for design, erection and fabrication, and acceptable standards of good practice. Finished members shall be true to line and free from twists and bends.
- C. SSPC "Steel Structures Painting Manual, Volume 2, Systems and Specifications".
- D. National Association of Architectural Metal Manufacturers (NAAMM): Metal Finishes Manual
- E. SSPC-SP1 Solvent Clean
- F. SSPC-SP2 Hand Tool Clean
- G. SSPC-SP3 Power Tool Clean
- H. SSPC-Surface Preparation Commentary for Metal Surfaces
- I. SSPC-SP6/NACE No. 3 Commercial Blast Clean
- J. SSPC-SP11 Power Tool Clean to Bare Metal
- K. SSPC-SP16 Brush-Off Blast Cleaning of coated and Uncoated Galvanized Steel, Stainless Steels and Non-Ferrous Metals

1.4 SUBMITTALS, per Section 013300

- A. Product Data: Furnish manufacturer's literature including paint, grout and recommendations for cleaning.

- B. Shop Drawings: Shall show dimensions, sizes, thicknesses, gauges, finishes, joining attachments and relationship of work to adjoining construction. Where items must fit and coordinate with finished surfaces and/or constructed spaces, take measurements at site and not from drawings. Where concrete, masonry or other materials must be set to exact locations to receive work, furnish assistance and directions necessary to permit other trades to properly locate their work. Where welded connectors, concrete or masonry inserts are required to receive work, shop drawings shall show exact locations required, and all such drawings shall be furnished to the trades responsible for installing the connectors or inserts. Catalogue work sheets showing illustrated cuts of item to be furnished, scale details and dimensions may be submitted for standard manufactured items.
 - 1. Provide templates for anchorage installations by others.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.
- D. Samples for Verification: For each type of exposed finish required.
 - 1. Furnish finish samples of uncoated steel anchor and bolts for farm machinery, etc. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. 6 in. square piece of each finish required by this section.
- E. Certificates: Submit certification signed by California registered civil or structural engineer indicating compliance with Contract Documents and code requirements where required.

1.5 SYSTEM DESCRIPTION

- A. Design Requirements: Drawings indicate metal sizes and shapes; unless otherwise specifically indicated, design components and fabrications of gages and thicknesses to withstand anticipated loads as required by California Building Code.
 - 1. Railings: Support a lateral force of 50 lbs./lin. Ft. uniform load and 200 lbs. at any single point without permanent set or damage; ASTM E 935.
 - a. Top Rails: Design to support minimum 200 lb. concentrated single point load applied at any point vertically or horizontally.
- B. Rail Regulatory Requirements:
 - 1. Access: Comply with California Building Code and Americans with Disabilities Act Accessibility Guidelines (ADAAG) Access Requirements and finishes as designated by NAAMM "Metal Finishes Manual" and "Pipe Railing Manual" and referenced standards. Rails shall be welded construction; cap exposed ends.
 - 2. Building Code: Comply with requirements of applicable building codes for railing design, except where more restrictive codes are specified.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm with minimum five years successful experience fabricating metal items similar to those required for Project.
- B. Source Limitations: Obtain each type of railing or screen from single source from single manufacturer.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including structural analysis, preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code-Aluminum."

E. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of each type of metal shown on Drawings.
2. Build mockups for each form and finish of guardrail consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 24 inches in length.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - MATERIALS

2.1 BASIC MATERIALS AND ACCESSORIES

- A. Steel Tubing: ASTM A500 (cold-formed), Minimum Grade B, seamless where exposed.
- B. Steel Pipe: ASTM A53, Type S, seamless, Grade A, minimum standard weight, STD or Schedule 40, unless otherwise noted.
- C. Miscellaneous steel plates and structural steel shapes conforming to ASTM A36-(latest edition).
- D. Bolts: Structural grade steel, ASTM A307-(latest edition), with suitable hex nuts and washers, all galvanized except where noted otherwise.
- E. Structural Steel Sheet: Hot rolled, ASTM A1011; or cold rolled, ASTM A 1008, Class 1 of grade required for design loading.
- F. Castings: Gray iron, ASTM A 48, Class 30; malleable iron, ASTM A47.
- G. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron ASTM A47 or cast steel ASTM A27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A153.
- H. Fasteners and Rough Hardware: Type as required for specific usage; provide zinc-coated fasteners for exterior use or where built into exterior walls.
- I. Welding Materials: AWS D1.1, type required for materials being welded.

- J. Stainless Steel
1. Plate, Sheet and Strip: ASTM A167, Type 316. Provide mill finish unless otherwise shown.
 2. Bars and Shapes: ASTM A276, Type 316. Provide mill finish unless otherwise shown.
 3. Tubing: ASTM A269
 4. Stainless Steel Railing Finishes: Submit finish sample for approval. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated free of cross scratches. Run grain with long dimension of each piece.
 5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- K. Aluminum: Provide alloy and temper recommended by aluminum producer or finisher for type and use and finish indicated; sized for strength and durability consistent with application involved. Comply with the following finishes as designated by NAAMM "Metal Finishes Manual" and referenced standards:
1. High performance Organic Coating: AA-C12C42R1x, prepared, pretreated and coated with minimum two coat system; AAMA 2605.
 2. Comply with following minimum standards for aluminum.
 - a. Extruded Bar and Shapes: ASTM B221, 6063-T6.
 - b. Extruded Pipe and Tube: ASTM B429, 6063-T6.
 - c. Drawn Seamless Tube: ASTM B483, 6063-T832.
 - d. Plate and Sheet: ASTM B209, 6061-T6.
 - e. Die and Hand Forgings: ASTM B247, 6061-T6.
 - f. Castings: ASTM B26, 356.0-T6.
- L. Weathering Steel: (COR-TEN), ASTM A242.
- M. Castings: Gray iron, ASTM A 48, Class 30; malleable iron, ASTM A 47.
- N. Screws: Galvanized zinc, electro-plated or brass.
- O. Welding Electrodes: As permitted by AWS A5.
- P. Galvanizing:
1. Hot-dip galvanize fabricated items as shown and specified after fabrication in accordance with ASTM A123-09, ASTM A153/A153M.
 2. Parts shall be made in suitable sections. First clean in a hot pickling bath to remove scale and then rinse clean with clear water. After pickling and washing, dip parts in liquid zinc tank sufficient length of time to heat parts to zinc temperature, then remove and allow to drip and cool; straighten as required.
- Q. Non-Metallic Shrinkage Resistant Grout: Premixed, nonmetallic, non-corrosive, non-staining, shrinkage resistant product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with CE-CRD-C621 and ASTM C1107, free of gas-producing or gas-releasing agents, oxidizing catalysts, inorganic accelerators and chlorides. Provide one of the following:
1. "Five Star Grout" (U.S. Grout Corp.).
 2. "Masterflow 713" (Master Builders Co.).
 3. "Crystex" (L&M Construction Chemicals, Inc.).
- R. Fasteners and Anchorage Devices: Provide fasteners complying with the requirements of Industrial Fasteners Institute standards. Type, grade, class and style best suited for the respective purpose. Use countersunk flat-head Phillips type machine screws for exposed fasteners, except where Allen head screws are required. Use galvanized steel or stainless steel fasteners for exterior construction and for fastening components fabricated of galvanized steel except where specified otherwise. Fasteners exposed in finish surfaces to match finish of adjacent surfaces.

- S. Component Connections: Fabricate component connections to support specified design loads.
- T. Material Selection: Select materials for straightness, free of defects and irregularities.
 - 1. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, "oil canning", stains, discolorations, and imperfections on finished units are not acceptable.
- U. Joints: Make exposed joints flush butt type, hairline joints where mechanically fastened; provide concealed connection devices with hidden fasteners.
 - 1. Fabricate continuous items with joints neatly fitted and secured.
 - 2. Ease exposed edges to approximate 1/32" uniform radius.
 - 3. Fabricate joints exposed to weather in manner to exclude water or provide weep holes where water could accumulate.
- V. Welding: Comply with AWS for recommended practices in welding each type of material; provide welds behind finished surfaces without distortion or discoloration on exposed side; dress exposed and contact surfaces.
- W. Exposed Mechanical Fastenings: Flush countersunk fasteners unobtrusively located, consistent with design of structure.
- X. Assemblage: fit and shop assemble in largest practical sections for site delivery.
- Y. Dissimilar Materials: Separate dissimilar materials with bituminous paint where concealed, with preformed separators, or similar method to prevent corrosion.

2.2 SPECIALLY FABRICATED PRODUCTS

- A. Railings and Handrails: Make all bar railings of milled steel unless noted otherwise; all connections welded. Where pipe railing is required, make from (1-1/2) outside diameter seamless steel pipe unless noted otherwise. Fabricate in largest sections feasible; all shop joints welded; all field joints with concealed sleeves and pins.
- B. Railings and Handrails Design: Continuous railings conforming to applicable code and design requirements. Construct to support a concentrated load of 250 lbs. Applied at any point and in any direction and for a uniform load of 50 lbs. Per foot applied in any direction. The concentrated and uniform loading conditions shall not be applied simultaneously.
 - 1. Wall Rail Brackets: Castings as accepted by Owner's Representative.
 - 2. Wall returns: 90 degree elbow return with 1/4" maximum clearance unless otherwise indicated.
 - 3. Provide wall plates only where indicated and where required by applicable codes.

2.3 SHOP PAINTING AND FINISHES

- A. General:
 - 1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment
 - 3. Shop paint miscellaneous metal work, except members or portions of members to be embedded in concrete or masonry, surfaces and edges to be field welded unless otherwise specified.
 - 4. Remove oil, grease and all visible soluble surface contaminants in accordance with SSPC SP-1 "Solvent Cleaning", prior to any additional surface preparation specified.
 - 5. Clean and prepare metal surfaces before applying shop coat.
 - a. Bare Ferrous Steel: SSPC-SP6/NACE No. 3 Commercial Blast Clean to exhibit a dense, uniform and angular surface profile of 2.0 mils minimum.

- b. Galvanized, Stainless and Non-Ferrous Metal: SSPC-SP16 Brush-Off Blast Clean to create a dense, uniform and angular surface profile of 1.5 mils minimum.
 6. Immediately after surface preparation, apply primer in accordance with manufacturer's instructions. Use painting methods which will result in full coverage and dry film thickness specified.
 - a. Use wet film thickness gauges during application.
 7. Apply one shop coat of primer to fabricated metal items.. In addition, apply one shop coat of finish paint to entire surfaces of exterior loose lintels, shelf and relieving angles, dunnage and other items as noted or specified. Change color of second or finish coat to distinguish it from the first coat.
 8. Separate dissimilar metals with one coat of dielectric separator. Do not extend coating onto exposed or finished surfaces.
 9. Application: Do not paint when ambient temperature is below 40°F. Paint in dry weather or under cover; paint over dry rust-free surfaces. Stir paint and keep at uniform consistency during application. Zinc-rich primers require continuous mechanical agitation. Apply paint per manufacturer's directions to recommended or specified dry film thickness. Do not thin paint in excess of manufacturer's recommendations. Allow paint to dry before handling or shipment.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.
- D. Powder-Coat Finish: Powder Coating: Cowel nylon coating powder applied per manufacturer's recommendations for exterior applications. Color to be selected by landscape architect from manufacturer's full range and is to match trench drain powder coat color.
- E. High Performance Coatings: Primers, Intermediate and Finish paint coatings manufactured by Tnemec Company are specified as the basis of design. Local: Amos And Associates, Inc.: 816-317-3206.
- F. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
- G. Fully Concealed Items:
 1. Clean steel work by "Solvent Cleaning" method specified in SSPC-SP 1, followed by "Hand Tool Cleaning" to remove loose mill scale and rust by methods specified in SSPC-SP 2.
 2. Apply ferrous metal primer immediately after.
- H. Exposed Exterior Items:
 1. Apply the following cleaning, treatment and painting to exterior work which will be fully exposed or only partially exposed, and to exposed interior work in areas designated as high humidity areas.
 2. Clean by "Solvent Cleaning" method specified in SSPC-SP 1, followed by "Power Tool Cleaning to Bare Metal " to remove mill scale and rust by methods specified in SSPC-SP 11 when abrasive blast cleaning is not practical. Otherwise, prepare surfaces per SSPC-SP6/NACE No. 3 Commercial Blast Clean.
- I. Preparation of Galvanized Metal
 1. Shop or Field Surface Preparation:

- a. SSPC-SP1 Solvent Clean all surfaces to remove visible and soluble surface contaminants before and after subjecting surfaces to SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals to create a dense, uniform and angular anchor profile of 1.5 mils minimum. When abrasive blasting is not practical, in lieu of SSPC-SP16, use power tools that create a surface profile and do not burnish the surface (i.e. Monti Power Bristle Blaster). However it is achieved, all surfaces shall be clean and free of all surface contaminants including passivated surfaces, shall be dry and shall be uniformly roughened to exhibit a dense and uniform anchor surface profile of 1.5 mils minimum before coating application. The purpose is not to remove zinc but to roughen the surface. If zinc is removed to expose substrate, bare substrate must be primed with a zinc-rich primer such as Tnemec Series 94-H2O | Hydro-Zinc.
 2. Power Tool clean cuts and welds to bright metal.
 3. Shop or Field Primer: Series L69 | Hi-Build Epoxoline II; 3.0 to 4.0 mils DFT (provide holdbacks as required for welding)
 4. Color Finish: Shop or Field Finish: Series 1070V | Fluoronar gloss or Series 1071V | Fluoronar semi-gloss or Series 1072V | Fluoronar satin (Color and Sheen TBD by Landscape Architect); 2.5 to 3.5 mils DFT
 5. Total DFT: 5.5 to 7.5 mils
- J. Preparation of Ferrous Metal
1. Surface preparation: SSPC-SP6/NACE No. 3 Commercial Blast Clean to create a dense, uniform and angular anchor profile of 2.0 mils minimum.
 2. Prime Coat: Series 94-H2O Hydro-Zinc or Series 90-97 Tnemec Zinc (meets Class B Slip for critical bolted connections); 2.5 – 3.5 mils DFT.
 3. Field Touch-Up Primer: Series 94-H2O Hydro-Zinc; 2.5 – 3.5 mils DFT
 4. Striping Existing Metal: Series L69 Hi-Build Epoxoline II brush applied to all bare and corroded surfaces, sharp edges, welds, nuts and bolts per SSPC-PA 1, 6.6 Striping, 7.4.6 Application Method.
 5. Intermediate Coat: Series L69 Hi-Build Epoxoline II; 4.0- 6.0 mils DFT.
 6. Color Finish: Shop or Field Finish: Series 1070V | Fluoronar gloss or Series 1071V | Fluoronar semi-gloss or Series 1072V | Fluoronar satin (Color and Sheen TBD by Owner); 2.5 to 3.5 mils DFT
 7. Total DFT: 8.0 – 13.0 mils

PART 3 - EXECUTION

3.1 CONDITION OF SURFACES: Inspect all surfaces to receive site metal work and report all defects which would interfere with this installation. Starting work implies acceptance of surfaces as satisfactory.

3.2 FIELD MEASUREMENTS: Take field measurements prior to preparation of shop drawings and fabrication, where possible; do not delay job progress; allow for trimming and fitting where necessary.

3.3 WORKMANSHIP

- A. Verify all measurements at job. Coordinate all metalwork with adjoining work for details of attachments, fittings, etc. Do all cutting, shearing, drilling, punching, threading, tapping, etc., required for site metalwork or for attachment of adjacent work. Drill or punch holes; do not use cutting torch. Shearing and punching shall leave true lines and surfaces. Obtain Owner's Representative's review prior to site cutting or making adjustments which are not part of scheduled work. Perform necessary cutting and altering for installation and coordination with other work.
- B. Conceal all fastenings where feasible. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Form joints exposed to weather to exclude water.

- C. Make all permanent connections in ferrous metal surfaces using welds where at all possible; do not use bolts or screws where they can be avoided.
- D. Provide all lugs, clips, anchors, miscellaneous fastenings necessary for complete assembly and installation.
- E. Set all work plumb, true, rigid, neatly trimmed out, accurately fitted and free from distortions or defects detrimental to appearance or performance. Miter corners and angles of exposed moldings and frames unless otherwise noted.
- F. Set railings where shown set in sleeves or cored with quick-setting non-shrink anchor cement. Size sleeves for approximately 1/4" clearance all around.
- G. Where items must be incorporated or built into adjacent work, deliver to trade responsible for such work in sufficient time that progress of work is not delayed. Be responsible for proper location of such items.
- H. Make provisions for erection stresses by temporary bracing; Keep work in alignment.
- I. Install ornamental metal items in accordance with manufacturer's recommendations, installation instructions, and approved shop drawings.
- J. Install items plumb, true and in correct relation to adjacent work, free from distortion or defects detrimental to appearance and performance.
- K. Prior to securing continuous items, adjust to ensure proper matching at butt joints and correct alignment throughout their length.
- L. Tolerances: Accurately align and locate components to required lines and levels to conform to following tolerances:
 - 1. Plumb: 1/8" in 10'-0"; 1/4" in 40'-0"; non-cumulative.
 - 2. Level: 1/8" in 20'-0"; 1/4" in 40'-0"; non-cumulative.
 - 3. Location: 3/8" maximum deviation from measured theoretical location (any member and location).

3.4 WELDING:

- A. Perform all welding in accordance with AWS Code D1.1. Welds shall be made only by operators experienced in performing the type of work indicated. Welds normally exposed to view in the finished work shall be uniformly made and shall be ground smooth. Where welding is done in proximity to glass or finished surfaces, such surfaces shall be protected from damage due to weld sparks, spatter, or tramp metal.
- B. Field Welding: Comply with AWS Welding Code for procedures related to field welding as related to appearance and quality of welds made and for methods used in correcting welding work. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.

3.5 BOLTED, SCREWED AND RIVETED CONNECTIONS

- A. In general, use bolts for field connections only and then only as detailed. Provide washers under all heads and nuts bearing on wood. Draw all nuts tight and nick threads of permanent connections to prevent loosening. Use beveled washers where bearing is on sloped surfaces.
- B. Where screws must be used for permanent connections in ferrous metal, use flat-head-type, countersunk, with screw slots filled and finished smooth and flush.

- C. Where rivets are used, they shall be machine-driven, tight, heads centered, countersunk, and finished flush and smooth.

3.6 GALVANIZING

- A. Galvanize fabricated items after fabrication in accordance with ASTM A123-66.
- B. Parts shall be made in suitable sections. First clean in a hot pickling bath to remove all scale and then rinse clean with clear water. After pickling and washing, dip parts in liquid zinc tank sufficient length of time to heat parts to zinc temperature, then remove and allow to drip and cool; straighten as required.

3.7 INSTALLATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and other miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to the project site. Deliver items which are to be built into the work of other Sections in time so as not to delay the progress of the Work.
- B. Protect finished surfaces against damage during construction and remove protection at time of substantial completion.
- C. Railings and Guardrails:
 - 1. Anchor posts of railings into concrete by means of pipe sleeves preset and anchored into concrete. Set sleeves in concrete with tops flush with finish surface elevations and protect sleeves from water and concrete entry. After posts have been inserted into sleeves, solidly fill annular space between post and sleeve with non-shrink non-metallic grout. Cover anchorage joint with a round steel flange welded to post after placement of anchoring material.
 - 2. Anchor posts to steel members with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to steel supporting members.
 - 3. Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements. Mount handrails only on gypsum board assemblies reinforced to receive anchors. Adjust railings prior to anchoring to ensure matching alignment at abutting joints. Locate posts at spacing indicated, or if not indicated, at equal intervals as required by design loadings.
 - 4. Secure handrails to wall with wall brackets and end fittings. Provide brackets of design shown, with flanges tapped for concealed anchorage and with not less than 1-1/2 in. clearance from inside face of handrail and finished wall surface. Located brackets as indicated, or if not indicated, at equal spacings as required by design loads.
- D. Loose Plates: Prior to setting loose bearing and setting plates, clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates. Set on wedges or other adjustable devices. After members have been positioned and plumbed, tighten anchor bolts. do not remove wedges or shims, but if protruding, cut off flush with the edge of the plate before packing with grout. Pack grout solidly between bearing surfaces and plates to ensure no voids remain.
- E. Immediately after erection, clean field welds, bolted connections, marred and abraded surfaces. Paint and touch-up paint with the specified paint system. Touch up galvanized surfaces in accordance with ASTM A780.
- F. Replace items damaged in course of construction.

3.8 PROTECTION AND CLEANING, per Section 017400

- A. Remove all soil and foreign matter from finished surface and apply such protective measures as may be required to prevent damage or discoloration of any kind until acceptance of project.

END OF SECTION

SECTION 328400 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Include: All labor, materials, supplies, tools and transportation to perform all operations in connection with and reasonably incidental to the complete installation of the automatic sprinkler irrigation systems as shown on the Drawings.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS:

- A. Final Acceptance for Work of this Section is contingent on completion of Work of Section 329000.
- B. Division 32 - Exterior Improvements: Irrigation sleeving under paving.

1.3 REFERENCES

- A. ASTM - American Society for Testing and Materials
 - 1. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. D1785 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40 and 80 and Classes 200 and 315.
- B. ICC - International Code Council
- C. NEC - National Electric Code
- D. State of California, Division of Industrial Safety
 - 1. Electrical Safety Orders
- E. UPC - Uniform Plumbing Code

1.4 QUALITY ASSURANCE

- A. OSHA Compliance:
 - 1. All articles and services covered by this Specification shall meet or exceed the safety standards established under the Federal Occupational Safety and Health Act of 1970, together with all amendments in effect as of the date of this Specification.
 - 2. The Contractor shall erect and maintain barricades, guards, warning signs, and lights as necessary or required by OSHA regulations for the protection of the public or workmen.
- B. Regulatory requirements: In addition to complying with all pertinent codes and regulations, comply with the latest rules of NEC and the Electrical Safety Orders of the State of California, Division of Industrial Safety, for all electrical work and materials. The materials and methods to be used in constructing the irrigation system shall conform to the applicable provisions of the UPC.
- C. When the Specifications call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, the provision of the Specifications shall take precedence over the requirements of the said rules and regulations.

- D. The Contractor shall furnish without any extra charge any additional material and labor when required by the compliance with these rules and regulations, though the work be not mentioned in these Specifications or shown on the Drawings.
- E. The Contractor shall not willfully install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in engineering. Such obstructions or differences should be brought to the attention of the College's Authorized Representative. If this notification is not performed, the Contractor shall assume full responsibility for any necessary revisions.
- F. Any existing buildings, equipment, piping, pipe covering sewers, sidewalks, landscaping, etc., damaged by the Contractor during their work shall be replaced or repaired by the Contractor in a manner satisfactory to the College's Agent and at Contractor's own expense, and before the final payment is made. The Contractor shall be responsible for damage caused by leaks in the piping systems being installed by them. They shall repair, at their own expense, all damage so caused, in a manner satisfactory to the College's Agent.
- G. The Contractor shall pay for all permits, licenses, and fees required.

1.5 SUBMITTALS

- A. Equipment/Materials List: Within 15 days after award of contract and prior to installation, submit six copies of materials list. Include manufacturer, model number, and description of all materials and equipment. Include sealants, cements, lubricants, and other proprietary items. Manufacturer cut-sheets may be used with items clearly identified on each page.
- B. Contractor shall submit the Equipment/Materials List as one complete package with all equipment to be used on the project included. Submittals submitted in 'piecemeal' fashion shall be rejected.
- C. Equipment/Materials List shall include a Table of Contents at the beginning of the package listing all materials and components of the irrigation system with corresponding page number. Equipment Submittals will be rejected as incomplete if T. of C. is not included. Although manufacturer and other information may be different, the following is a guide to proper layout of submittal format:

Item No.	Description	Manufacturer	Model No.	
	Pg. No.			

1.	Backflow Preventor	FEBCO	825YA	1
2.	Mainline Isolation Ball Valve	LASCO	Vxx101N-SC	3
3.	QCV	Rain Bird	33-RC	5
4.	QCV Key	Rain Bird	33-DK	6

- D. Substitutions: Submit PDF copies of catalog information on materials which are to be submitted for substitution. No substitution will be permitted without prior written approval by the Architect. A complete material list shall be submitted prior to performing any work.
- E. Provide a copy of the completed submittal list within the Operation and Maintenance Manual.
- F. Unit Pricing Chart: The contractor shall provide a PDF copy as part of the Submittal Package to the College's Authorized Representative a 'Unit Pricing Chart' for installed equipment supplied to the project. Chart to be used for future add/deduct purposes that may occur during the construction of the irrigation system. Refer to section 1.6.
- G. Equipment or materials installed or furnished without prior approval of the College's Authorized Representative may be rejected and the Contractor required to remove such materials from the site at his own expense.

- H. Any manufacturer's warranties shall not relieve the Contractor of his liability under the Guarantee. Such warranties shall only supplement the Guarantee.
- I. As-built Plans:
1. The Contractor shall maintain in good order, in the field office, one complete set of blueprints of all irrigation drawings which form a part of the Contract.
 - a. Any work not installed as indicated on the Drawings, shall be recorded, and dimensioned accurately from the buildings/walls and/or curbs/sidewalks on 'as-built' prints. Including controllers, mainline routing, backflow assemblies, all valve box locations for master valves, flow sensors/meters, RCV assemblies, QCV's, mainline isolation valves, drip flush valves, drip air relief valves, and stub-outs.
 - b. All as-built markups shall be indicated in red.
 - c. All underground stub-outs for future connections and valves shall be located and dimensioned accurately from building walls on these record drawings.
 2. Upon completion of the work, on a new set of drawings, obtain reproducible prints from Architect and neatly correct the prints to show the as-built conditions.
- J. Record Drawings:
1. Upon approval of the 'as-built' drawings, produce the Record Drawings in electronic form on latest project base files using AutoCAD drafting software 2023 or later version and upon completion provide the Record Drawings in PDF format. After approval of the Record Drawings the contractor shall finalize the Record Drawings to be included in the O&M manual.
 - a. If unable to complete an electronic form of the Record Drawings deliver an approved hardcopy of the 'As-built' Record Drawings to Irrigation Consultant, Brinkerhoff and Associates, (760) 703-7108. Brinkerhoff and Associates shall provide the Contractor electronic drafting as a separate service. Service fee shall be according to project size. Brinkerhoff and Associates shall determine the fee and Contractor shall pay the fee before work commences. Brinkerhoff and Associates shall input 'As-built' Record Drawing information from Contractor into the electronic base files using AutoCAD 2024 drafting software or later version. After completion Brinkerhoff and Associates shall e-transmit the electronic Record Drawings and provide a PDF file of the irrigation sheets to the Landscape Architect and/or Contractor.
 2. For Record Drawings include new valve callouts at the actual as-built RCV locations. Remove all 'old' callouts, RCV's, and original mainline routing from the Record Drawings to declutter the drawing. Also, include the actual measured flow for each RCV for future troubleshooting purposes.
 3. Include any wording, documentation in the Title Block and/or sheets as required by College and/or Landscape Architect.
 4. Include a box, with text wipeout feature to minimize clutter, with an abbreviated Legend of the equipment and line types on each sheet for easy identification.
- K. Controller Irrigation Zone Charts:
1. Record Drawings shall be accepted by the Architect before controller charts are prepared.
 2. Provide one controller chart for each controller supplied.
 3. Prior to Pre-Maintenance Substantial Completion Observation, prepare Controller Irrigation Zone Chart from a reduced copy of the approved Project 'As-Built' Record Drawings produced from AutoCAD software, with irrigation zones clearly highlighted in differing colors and each valve number clearly highlighted at the reduced scale produced from AutoCAD software to the Landscape Architect for review and approval. After approval, the Contractor shall produce the same chart for use within the controller cabinet. The reduced zone plan shall be cut to fit flat within the controller; each sheet laminated in plastic and placed in the controller before the Pre-maintenance site review. Size of project shall determine number of sheets. If more than one sheet is required, then sheets shall be attached together with a key ring.

4. If unable to complete an electronic form of the colored zone chart deliver a hand-colored chart produced from an approved hardcopy of the 'As-built' Record Drawings to Irrigation Consultant, Brinkerhoff and Associates, (760) 703-7108. Brinkerhoff and Associates shall provide electronic drafting as a separate service to the Contractor. Service fee shall be according to project size. Brinkerhoff and Associates shall determine the fee, and Contractor shall pay the fee before commencing work. Brinkerhoff and Associates shall input controller zone information from Contractor into the electronic approved Record Drawing files using AutoCAD 2023 drafting software or later version. After completion, Brinkerhoff and Associates shall provide a PDF file of the zone chart to the Landscape Architect and/or Contractor.

Charts shall be the maximum size that the controller door will allow, showing areas covered by each controller. The chart shall be an electrostatic copy and a different color shall be used to indicate area of coverage for each station. Enlarge valve sequence to be readable when drawing is reduced.

After being completed and accepted, seal by plastic laminating. Laminating sheets shall be a minimum of 5 mil thick.

- L. Controller Anticipated Run-Time Schedule Chart:
 1. At or prior to the Final Substantial Completion Observation Review, provide a 12-month controller run-time schedule chart for each IRRIGATION ZONE on the controller to the Irrigation Consultant for review and approval. After approval, place on back side of color-highlighted approved Controller Irrigation Zone Chart and laminate together. Anticipated Controller Run-time Schedule Charts shall be developed using historical evapotranspiration rates for the area, individual zone precipitation rates, necessary crop factors, and irrigation system efficiencies by zone as the basis for the schedule and shall show such within the chart. If repeat cycles are required due to runoff issues, note the proper number of repeat operations and the timing of each repeat. The total run time for all daily cycles shall not be longer than the maximum allowed water window per local water agency regulations. The watering days per week or month shall be such as to permit system operation to be close to the maximum water window allowed.
 - a. Brinkerhoff and Associates, Irrigation Consultants (760-703-7108), shall provide a service to produce Controller Run-time Schedule Charts at Contractor's request. Service fee varies depending on the total zone count for each controller.
- M. Operations and Maintenance Manual:
 1. Deliver a PDF file to the Landscape Architect at least 5 days prior to Final 'Walk-Through' and completion of construction a complete set of the following data.
 - a. *Index:* Include sheet stating installing Contractor's address and telephone number and a full Table of Contents with section identifying index tabs showing page groupings. Show all page numbers within each section. Sections may be taken from numbered headings as shown below. Individual page numbers shall be placed on every sheet. Every page shall be numbered sequentially starting with 1 to the last page. No page shall have the same number. Place page number at the bottom right corner of each page. i.e. example of SECTION HEADINGS (examples of Sections only, Section page numbering will differ.)

Warranty Certificate	page 5
Manufacturers' Warranty Certificates	pages 6-12
Record Drawing	page 13
Approved Submittal Lists	pages 20-30
Catalog Materiel Cut Sheets	pages 31-100
Installation, Operation, Maint, & Trblshting	pages 120-350
Controller	pages 120-310
Backflow Assembly	pages 311-319
Master Valve	pages 320-325
Flow Sensor	pages 326-329
RCV's	pages 330-333
QCV's	pages 334-336
Dripline	pages 337-350

Etc.

- b. Name and Addresses: Include list of equipment with name, email address, and physical addresses of local manufacturer's representatives and name, address, and phone number of local supplier of irrigation materials used on the project.
- c. Warranty Certificate: Include contractor's irrigation system warranty certificate.
- d. Manufacturers' Warranty Certificates: Include manufacturer's equipment warranty certificates including controller.
- e. Testing and Commissioning: Include all documents pertaining to the testing and commissioning of the irrigation system, i.e. certifications for pump assembly, backflow assembly, controller assembly, etc.
- f. Record Drawings: Include 11x17 sheets of the Final Record Drawings. Record Drawings only to be completed from the landscape architect approved set of as-built plans.
- g. Irrigation Plan As-built's: Include 11x17 sheets of the As-built drawings.
- h. WELO Certificate of Completion: Include document as approved by the prevailing City/Water Agency.
- i. WELO Irrigation Inspection and Audit Report: Include report conducted by an Irrigation Association certified (CLIA) third-party Water Auditor.
- j. List of Extra Stock: Include all extra products supplied as part of the "Turn Over Items". List by manufacturer, model, and quantity.

- k. Catalog Material Cut Sheets: Include all products used on the project. Copies of all material submittals meet the requirement.
 - l. Approved Submittal List: Copy of the Irrigation Consultant Approved Submittal Equipment/Materials List(s).
 - m. Catalog Material Cut Sheets: Include all products used on the project. Copies of all material submittals meet the requirement.
 - n. Installation, Operation, Maintenance, & Troubleshooting: Include specific manufacturer's Installation, Operation, Maintenance, and Troubleshooting manuals for each product.
 - 1) Controller Assembly: Include specific manufacturer's Installation, Operation, and Maintenance Manual for the product.
 - 2) Decoders: Include specific manufacturer's operation and maintenance manual for the decoders.
 - 3) Backflow Assembly: Include specific manufacturer's maintenance manual for the assembly.
 - 4) Remote Control Valves (RCV's): Include specific manufacturer's operation, maintenance manual, and parts list breakdown for the product. Include manufacturer's "Valve Troubleshooting Guide".
 - 5) Sprayhead Bodies: Include specific manufacturer's operation and maintenance manual and parts list breakdown for the bodies.
 - 6) Sprayhead Nozzles: Include specific manufacturer's operation and maintenance manual for the spray nozzles.
 - 7) Rotary Nozzles: Include specific manufacturer's operation and maintenance manual for the rotator nozzles.
 - 8) Bubbler/Emitter Nozzles: Include specific manufacturer's operation and maintenance manual for the bubbler/Emitter nozzles.
 - o. Controller Zone Chart: Chart(s) shall include all zones separated by different colors easily readable at a 11x17 size. Provide the same zone chart(s) included in the controller cabinet.
 - p. Controller Watering Schedule Chart: Provide a 12-month watering schedule for maintenance crew reference. Include and separate each zone of the complete system. Show run time for each zone. Base each zone's runtime on ET factors and environmental constraints such seasons, sunny areas, shaded areas, plant types, etc.
 - q. Record and chart the 2-wire path ground resistance at each grounding point to provide a baseline resistance measurement from which to set expectations for future troubleshooting. Refer to '2-WIRE PATH DECODER GROUNDING' Subsection 3.16 & 3.17.
 - r. Establish and record a baseline operating pressure from which to set expectations for future troubleshooting. Record and chart the dynamic pressure (zone under operation) of every zone. Set up a pressure gauge at the end of each zone. (1.) Overhead system: last sprinkler (2.) Drip system: farthest zone flush valve.
2. Provide an Irrigation Maintenance Schedule to include, but not be limited to, routine inspection, adjustment, and repair of the irrigation system and its components. See sample chart below. *List only activities pertinent to this project.

IRRIGATION SYSTEM MAINTENANCE SCHEDULE CALENDAR					
ITEM	ACTIVITY	DAILY	WEEKLY	MONTHLY	YEARLY
1	Check system for leaks.	X			
2	Check for broken or vandalized sprinklers.	X			
3	Check for vandalism within other parts of the system.	X			
4	Test operate complete system to check for operational issues and nozzle alignment issues.		X		
5	*Check any tree deep-well bubbler tubes for standing water (before any zone operation). If found adjust zone run time to eliminate standing water.		X		
6	*Check and adjust sub-surface dripline tie-down U-stakes. Pedestrian traffic and other sources may displace driplines from intended position.		X		

7	<p>*Check and adjust sub-surface dripline location and depth. Pedestrian traffic and other sources may displace driplines from intended position.</p>		X		
8	<p>*Check and adjust 1/4" distribution tubing location and depth. Pedestrian traffic and other sources may displace tubing from intended position.</p>		X		
9	<p>*Check and adjust 1/4" distribution tubing stakes. Pedestrian traffic and other sources may displace tubing from intended position.</p>		X		
10	<p>*Check spot drip emitters for missing PC diffuser caps for systems which use the PC diffuser caps. Pedestrian traffic, vandalism, and other sources may displace caps from the emitter.</p>		X		

11	<p>*Rain Bird Basket Screen Filters: Check drip filter indicator (must be observed during zone operation only) for green or red colored indicator on top of filter. If all green, no further action required. If green/red mix flush filter element. If all red, flush or replace the 200-mesh filter element with a new unit. When flushing element also flush debris from inside filter body as may be required.</p>			6-9 MONT HS	
12	<p>*Netafim Disc Filters: Open filter housing and flush filter rings. When flushing element also flush debris from inside filter body as may be required.</p>			6-12 MONT HS	
13	<p>*Rain Bird Basket Screen Filters: Flush or replace filter elements-see #11. (when the filter indicator says flushing is required).</p>			6-9 MONT HS	
14	<p>Flush system piping for each drip zone via the flush valves.</p>	<p>AFTE R ANY</p>		3-4 MONT HS	

		REP AIR			
15	Clean out all equipment valve boxes, including debris and excess dirt that has filtered in the valve box for ease of equipment maintenance.				X
16	Reset all valve box heights to specification.				BI-Y EAR LY
17	Conduct irrigation audit to determine if irrigation system is within the expected efficiency parameters set forth in CA AB1881 (W.E.L.O.).				5 YEA RS

N. Equipment to be furnished:

1. Supply as part of this contract the following tools:
 - a. Two (2) sets of special tools required for removing, disassembling, and adjusting each type of sprinkler and valves supplied on the project.
 - b. Two (2) 5-foot valve keys for operation of ball/gate valves.
 - c. Two (2) keys for each automatic controller and controller enclosure.
 - d. Two (2) quick coupler keys with corresponding sized bent-nose garden hose bibb / hose swivel.
2. The above-mentioned equipment shall be turned over to the College at the conclusion of the project. Before the Final Walk-Through is performed, evidence that the College has received this material must be shown to the College's Authorized Representative.

1.6 UNIT PRICING

- A. As part of the submittal review process the contractor shall provide a PDF copy as part of the Submittal Package to the Landscape Architect / Owner's Authorized Representative with a 'Unit Pricing Chart' for installed equipment supplied to the project. The contractor shall review the irrigation legend and details and provide the required unit pricing matrix. The chart shall include items required in constructing the irrigation system for this project. The following chart may be used as a template. Need only to include the equipment/material items to be used on this project.

UNIT PRICING CHART

EQUIPMENT / ASSEMBLY	UN IT	PRICE

RCV ASSEMBLIES		
1" RCV ASSEMBLY-OVERHEAD SYSTEMS, including valve box	ea.	\$ -
1-1/2" RCV ASSEMBLY-OVERHEAD SYSTEMS, including valve box	ea.	\$ -
2" RCV ASSEMBLY-OVERHEAD SYSTEMS, including valve box	ea.	\$ -
1" RCV ASSEMBLY-DRIP SYSTEMS, including valve box(s)	ea.	\$ -
1-1/2" RCV ASSEMBLY-DRIP SYSTEMS, including valve box(s)	ea.	\$ -
1" RCV ASSEMBLY-MICRO_SPRAY SYSTEMS, including valve box(s)	ea.	\$ -
1-1/2" RCV ASSEMBLY-MICRO_SPRAY SYSTEMS, including valve box(s)	ea.	\$ -
1" RCV ASSEMBLY-BUBBLER SYSTEMS, including valve box(s)	ea.	\$ -
1-1/2" RCV ASSEMBLY-BUBBLER SYSTEMS, including valve box(s)	ea.	\$ -
2" RCV ASSEMBLY-BUBBLER SYSTEMS, including valve box(s)	ea.	\$ -
QCV ASSEMBLIES		
3/4" QCV ASSEMBLY, including isolation	ea.	\$ -

valve & valve boxes		-
1" QCV ASSEMBLY, including isolation valve & valve boxes	ea.	\$ -
ISOLATION VALVE ASSEMBLIES		
1" MAINLINE ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
1-1/2" MAINLINE ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
2" MAINLINE ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
2-1/2" MAINLINE ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
3" MAINLINE ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
1" MAINLINE ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
1-1/2" MANIFOLD ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
2" MANIFOLD ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
2-1/2" MANIFOLD ISOLATION VALVE ASSEMBLY, including valve box	ea.	\$ -
3" MANIFOLD ISOLATION VALVE	ea.	\$ -

ASSEMBLY, including valve box		-
SPRAY BODY INSTALLATION		
FIXED SPRAYHEAD ASSEMBLY, spray nozzle	ea.	\$ -
FIXED SPRAYHEAD ASSEMBLY, rotary nozzle	ea.	\$ -
FIXED SPRAYHEAD ASSEMBLY, bubbler nozzle	ea.	\$ -
4" POP-UP SPRAYHEAD ASSEMBLY, bubbler nozzle	ea.	\$ -
6" POP-UP SPRAYHEAD ASSEMBLY, spray nozzle	ea.	\$ -
6" POP-UP SPRAYHEAD ASSEMBLY, rotary nozzle	ea.	\$ -
6" POP-UP SPRAYHEAD ASSEMBLY, bubbler nozzle	ea.	\$ -
12" POP-UP SPRAYHEAD ASSEMBLY, spray nozzle	ea.	\$ -
12" POP-UP SPRAYHEAD ASSEMBLY, rotary nozzle	ea.	\$ -
12" POP-UP SPRAYHEAD ASSEMBLY, bubbler nozzle	ea.	\$ -
ROTOR BODY INSTALLATION		

3/4" FIXED ROTOR ASSEMBLY	ea.	\$ -
4" POP-UP 1" ROTOR ASSEMBLY	ea.	\$ -
6" POP-UP 3/4" ROTOR ASSEMBLY	ea.	\$ -
6" POP-UP 1" ROTOR ASSEMBLY	ea.	\$ -
12" POP-UP 3/4" ROTOR ASSEMBLY	ea.	\$ -
DRIP/BUBBLER INSTALLATION		
POINT SOURCE ASSEMBLY-DRIP	ea.	\$ -
POINT SOURCE ASSEMBLY- XERI-BIRD TREE MANIFOLD, including valve box	ea.	\$ -
POINT SOURCE ASSEMBLY- BUBBLER	ea.	\$ -
DRIP ZONE-FLUSH VALVE ASSEMBLY	ea.	\$ -
DRIP ZONE-AIR RELIEF VALVE ASSEMBLY	ea.	\$ -
DRIP ZONE-OPERATION INDICATOR ASSEMBLY	ea.	\$ -

DRIP ZONE-TREE IRRIGATION DRIP MANIFOLD ASSEMBLY	ea.	\$ -
DEEP-WELL BUBBLER ASSEMBLY	ea.	\$ -
DRIPLINE TUBING INSTALLATION	lin. ft.	\$ -
PIPE SLEEVE INSTALLATION		
1-1/2" PIPE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
2" PIPE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
2-1/2" PIPE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
3" PIPE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
4" PIPE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
6" PIPE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
1-1/2" PIPE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -
2" PIPE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -

2-1/2" PIPE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -
3" PIPE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -
4" PIPE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -
6" PIPE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -
1-1/2" WIRE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
WIRE SLEEVE INSTALLATION		
1-1/2" WIRE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
2" WIRE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
2-1/2" WIRE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
3" WIRE SLEEVE-UNDER VEHICULAR PAVING	lin. ft.	\$ -
1-1/2" WIRE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -
2" WIRE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -

2-1/2" WIRE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -
3" WIRE SLEEVE-UNDER PEDESTRIAN PAVING	lin. ft.	\$ -
MAINLINE PIPE INSTALLATION		
1" MAINLINE PIPE	lin. ft.	\$ -
1-1/4" MAINLINE PIPE	lin. ft.	\$ -
1-1/2" MAINLINE PIPE	lin. ft.	\$ -
2" MAINLINE PIPE	lin. ft.	\$ -
2-1/2" MAINLINE PIPE	lin. ft.	\$ -
LATERAL LINE PIPE INSTALLATION		
1/2" LATERAL LINE PIPE	lin. ft.	\$ -
3/4" LATERAL LINE PIPE	lin. ft.	\$ -
1" LATERAL LINE PIPE	lin. ft.	\$ -
1-1/4" LATERAL LINE PIPE	lin.	\$

	ft.	-
1-1/2" LATERAL LINE PIPE	lin. ft.	\$ -
2" LATERAL LINE PIPE	lin. ft.	\$ -
2-1/2" LATERAL LINE PIPE	lin. ft.	\$ -
DECODER 2-WIRE CABLE INSTALLATION		
DECODER 2-WIRE CABLE (include electrical conduit)	lin. ft.	\$ -
DECODER 2-WIRE CABLE GROUNDING ASSEMBLY	ea.	\$ -

1.7 LAYOUT OF WORK

- A. The irrigation Contractor shall stake out the irrigation system as shown on the Drawings. Stake locations shall be approved by Landscape Architect before construction is started. Any changes, deletions or additions shall be determined in this check.

1.8 GROUNDING

- A. In all cases, where it does not conflict with appropriate grounding grid design for the site in question, ground rods or plates as referred to in this specification shall conform to the following standards.:
 1. The installer shall follow the manufacturer's grounding specifications.
 2. The installer shall provide adequate earth ground.
 - a. Resistance readings of 10 ohms or less are desirable, and a reading of no more than 15 ohms is required at all grounding points including the 2-wire and chassis ground.
 - b. The installer shall comply with practices defined in the American Society of Irrigation Consultants Earth Grounding Electronic Equipment in Irrigation Systems-Guidelines, available at www.asic.org.
 3. The installer shall install a ground rod or ground plate every 450-500 feet on the two-wire, and on the end of every spur that exceeds 50 feet. In high lightning areas, grounding should be increased to one every 300 feet.
 4. Grounding rods shall be located the length of the grounding rod away from the two-wire path.
 - a. There shall be a 6-gauge bare copper wire connecting the grounding rod to the surge arrester.

5. Grounding plates shall be located a distance equal to the diagonal measurement of the grounding plate from the two-wire path. The longest side of the grounding plate shall run parallel to the two-wire path.
 - a. There shall be a 6-gauge bare copper wire connecting the grounding plate to the surge arrester.
6. The surge arrester shall be located in a valve box and shall not be built into the decoder.

1.9 INSTRUCTION

- A. After the system has been installed and approved, the Contractor shall instruct the College's representative in complete operation and maintenance of the irrigation system.
- B. During the maintenance period, the Contractor shall be responsible for the set up and implementation of a formal education and training period (1 day) for the benefit of the College's landscape maintenance staff or other College designated representative. The purpose of the training shall be to explain the function and operation of equipment as may be necessary to fully understand the operation of the irrigation system. The education and training shall be to the satisfaction of the College's landscape maintenance staff or other College designated representative. The maintenance period may continue, at the College's discretion, until College's landscape maintenance staff or other College designated representatives are trained to their satisfaction. Items covered should include but not be limited to the following:
 1. Irrigation controller's features and its capabilities.
 2. Irrigation controller's ET sensor and its capabilities.
 3. Controller programming techniques and sequences.
 4. Review current watering schedules (pre-establishment) and informed explanation why it is such.
 5. Review and instruction for future watering schedules (post-establishment) and informed explanation why it is such.
 6. Troubleshooting techniques for minor controller issues.
 7. Operation of RCV's.
 8. Operation of QCV's.
 9. Operation of flow sensor or hydrometer valve.
 10. Proper drip zone flushing technique.
 11. Review and familiarization of drip system components and their operation, including filters, inline tubing, emitters, and multi-outlet manifolds.
 12. Set up a required schedule calendar for drip filter review and zone flushing frequency.
 13. Troubleshooting techniques for minor valve issues.
 - a. Valve won't open.
 - b. Valve won't close.
 - c. Valve is leaking.
 - d. Solenoid replacement.
 - e. Adjustment and replacement of sprinkler nozzles.
 - f. Troubleshooting techniques for minor sprinkler issues.

1.10 WARRANTY

- A. Provide 1-year guarantee for Work of this Section in accordance with Section 1700.
- B. Provide supplemental guarantee, on Contractor's letterhead:
 1. Warrant that irrigation system has been installed according to Drawings and Specifications, and that system will be free of defects in products and installation for 1 year from Substantial Completion. Manufacturer's warranties shall only supplement special warranty.
 2. Agree to repair or replace defective Work, or adjacent work which is damaged by such defects, with the exception of ordinary wear and tear, abuse or neglect. This includes damage to site improvements caused by settlement of improperly compacted trench backfill.
 3. The College reserves the right to make temporary repairs as required.

PART 2 - MATERIALS

2.1 PVC PIPE AND FITTINGS-MAINLINE

- A. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454 A or 12454 B, ASTM Standard D1784, with an integral belled end.
- B. Where shown on the Drawings use Schedule 40 conforming to the dimensions and tolerances established by ASTM Standard D1785 for mainline pipe. Refer to Drawings.
- C. Where shown on the Drawings use Class 315, SDR 13.5, rated at 315 PSI, conforming to the dimensions and tolerances established by ASTM Standard D2241 for mainline pipe. Refer to Drawings.
- D. Use PVC SCH 40 for mainline fittings with a nominal diameter equal to 1-1/2 inches or less.
- E. Use PVC SCH 80 for mainline fittings with a nominal diameter of 2 inches to 2-1/2 inches, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784.
- F. Use SCH 80, Type 1, PVC for all threaded fittings up to 2-1/2 inches.
- G. Use primer approved by the pipe manufacturer. Solvent cement to conform to ASTM Standard D2564.
- H. The INLET tee/el fitting and SCH 80 nipple used to connect a remote-control valve manifold assembly to the main line shall be of the same size as the nominal diameter of the OUTLET LATERAL of the valve. Use SCH 80 Soc x Fipt female adapter, SCH 80 Mipt x Fipt reducer (T.T.) bushing and SCH 80 nipple as required to connect the remote-control valve to the inlet SCH 80 nipple.
- I. Lateral lines (non-pressure) shall be Schedule 40 polyvinyl chloride (PVC) plastic pipe, Type 1, and shall conform to ASTM D1784. Use Schedule 40 PVC solvent weld fittings.
- J. Metal Pipe:
 - 1. Where indicated in the drawings, steel pipe shall be Schedule 40 galvanized steel conforming to ASTM 53B. Metal pipe shall be wrapped in 2-inch wide, 20 mil thick, black PVC all weather corrosion-resistant tape with high tack adhesive. Use threaded galvanized steel fittings.
 - 2. Where indicated on the Drawings, use red brass screwed pipe conforming to Federal Specification #WW-P-351.
 - 3. Brass fittings shall be red brass conforming to Federal Specification #WW-P-460.
 - 4. Copper pipe shall be Type K conforming to ASTM B88 with solder joint type wrought copper fittings.
 - 5. Provide dielectric fittings where dissimilar metals come into contact.
- K. Fittings:
 - 1. Solvent Weld socket fittings: CL315 for pipe size larger than 2-1/2". Schedule 40, Type 1, Grade 1, PVC and shall conform to ASTM D2466. Schedule 80, Type 1, Grade 1 PVC and shall conform to ASTM D2467. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type recommended by pipe manufacturer.
- L. Connections between main lines and remote-control valves shall be of Schedule 80 PVC (threaded both ends) nipples and fittings.
- M. Risers shall be as follows: Schedule 80 PVC threaded nipples and Schedule 80 PVC ells as shown on the construction details.

2.2 PIPELINE LOCATION MATERIALS

- A. Detectable Marker Tape- Plastic marker tape shall be 5 mil minimum thickness with a solid aluminum core of .35mil minimum thickness and a minimum width of 2". The background of the tape shall be colored based on pipe service with black lettering continuously printed. Marker tape shall have a minimum 35 lbs./inch tensile strength. The installation of the tape shall be at 18 inches below finish grade.

2.3 QUICK COUPLING VALVES

- A. Quick Coupling valves shall be brass construction, 3/4-inch connection, one piece body, non-locking vinyl top, single / double track key slot.
- B. Provide two 3/4-inch keys with 3/4" bent-nose garden valve, Buckner, model I-401, or Arrowhead Brass, model GV75F-V attached.
- C. QCV swing joint assemblies shall consist of brass nipples and fittings.
- D. Provide two Rain Bird cover keys, model #2049I per project when locking covers are specified.
- E. As listed in the Drawings. Refer to irrigation legend for manufacturer type and model.

2.4 GATE VALVES

- A. 2½ inch and smaller shall be 125 PSI CSP bronze construction conforming to ASTM B 62 with screw-in bonnet, non-rising stem, threaded connections.
- B. Gate valves are to be installed for mainline isolation.
- C. As listed in the Drawings. Refer to irrigation legend for manufacturer type and model.

2.5 BALL VALVES

- A. Ball valves shall be Schedule 80 PVC full port design.
- B. PVC ball valves are to be installed for manifold shutoff or upstream of the remote-control valve when only one valve is installed on the mainline.
- C. As listed in the Drawings. Refer to irrigation legend for manufacturer type and model.

2.6 REMOTE CONTROL VALVES

- A. Remote control valves shall be globe pattern constructed of heavy-duty glass-filled reenforced nylon with fabric-reinforced EPDM diaphragm and stainless-steel bolts with internal and external bleed. Operating pressure shall be 20 to 200 psi and flow range shall be 0.10-200 GPM as determined by manufacturer and valve size. All internal parts shall be removable from the top.
- B. When shown in drawings, install pressure regulating module on remote control valves. Pressure regulating module shall be by same manufacturer as remote control valve.
- C. Two SCH 80 unions shall be part of the valve assembly as shown in the drawings. Unions shall be installed within valve box for easy access.
- D. Each valve shall have a plastic tag denoting its controller and station number.
- E. RCV as listed in the Drawings. Refer to irrigation legend for manufacturer type and model.

2.7 REMOTE CONTROL DRIP VALVE ASSEMBLIES

- A. Remote control valves shall be globe pattern constructed of heavy-duty glass-filled reenforced nylon with fabric-reinforced EPDM diaphragm and stainless-steel bolts with internal and external bleed. Operating pressure shall be 20 to 200 psi and flow range shall be 0.10-200 gpm as determined by manufacturer and valve size. All internal parts shall be removable from the top.
- B. A 74-micron (200 mesh) screen filter shall be part of the valve assembly as shown in drawings.
- C. Install pressure regulating module on drip/micro-spray valve assembly as shown on drawings.
- D. Two SCH 80 unions shall be part of the valve assembly as shown in the drawings. Unions shall be installed within valve box for easy access.
- E. Each valve shall have a plastic tag denoting its controller and station number.
- F. Assembly shall include two interlocking valve boxes. Bottom box shall be inverted.
- G. RCV assembly as listed in the Drawings. Refer to irrigation legend for manufacturer's type and model of each component of assembly.

2.8 DECODER CONTROL CABLE

- A. 2-wire decoder cable. As listed in Drawings.
- B. 2-wire decoder cable shall be installed within 1-1/4" electrical conduit.
- C. Splices shall be made with SPEARS DS-400 connectors.

2.9 SYSTEM GROUNDING

- A. Decoders:
 - 1. Decoder grounding equipment includes a copper ground plate and 50 pounds of PowerSet® earth contact material. Make connections with CadWeld®. No other connections shall be approved.
- B. Splices shall be made with SPEARS DS-400 connectors.

2.10 2- WIRE CABLE SYSTEM GROUNDING

- A. Controller Unit:
 - 1. The grounding circuit will include an 8'copper-clad steel ground rod, a copper ground plate, #6-gauge wire, and 100 pounds of PowerSet® earth contact material. Make connections with CadWeld®. No other connections shall be approved.
- B. Grounding Rods and Plates:
 - 1. All grounding rods shall be bare copper 5/8-inch diameter or greater and a minimum of 8 feet long or longer.
 - 2. A 10-inch round valve box shall be installed over the top of the grounding rod to facilitate the use of a clamp-on ground resistance tester.
 - 3. All grounding plates shall be a minimum of 5 square feet (1.5 m²) as outlined in ASIC Earth Grounding Electronic Equipment in Irrigation Systems-Guidelines.
 - 4. A 10-inch round valve box shall be installed over the top of the ground plate connection to facilitate the use of a clamp-on ground resistance tester.

5. Grounding rods and plates shall be located at a minimum distance from the two-wire to assure that the two-wire path is outside of the electrode sphere of influence. Refer to Grounding Detail in Irrigation Plans for required distances.
 6. Consult the ASIC Earth Grounding Electronic Equipment in Irrigation Systems- Guidelines for correct minimum recommended distances for different ground rod or ground plate sizes and grounding grid designs.
 7. Make rod/wire connections with CadWeld®. No other connections shall be allowed.
- C. Splices shall be made with SPEARS DS-400 connectors.
- D. Surge Arrestors:
1. The surge arrestors shall be fully sealed, submersion proof made for direct bury, and shall effectively seal moisture from electronics. The surge arrestors shall be installed as specified herein.
 2. The surge arrestor shall come with 2 levels of surge protection that will clamp at 60 volts in less than 1 microsecond.
 3. The surge arrestor shall clamp closed to dissipate all surges to earth ground and protect other devices on the two-wire path.
 4. Each surge arrestor shall come with 23 inches of 16-gauge PVC jacketed solid core wire to connect to the two-wire path.
- E. Pedestal Enclosure Grounding:
1. If the controller enclosure is within 25 feet of an existing building, and does not conflict with appropriate grounding grid design for the site in question, the unit shall be grounded as outlined below:
 - a. The ground lug, located in the interior on the back panel in the lower-left corner under the AC power box in the pedestal cabinet, shall be connected directly to the building ground using a bare copper wire of 6-gauge or, as outlined in article 250 of the National Electric Code (NEC™) such that a single point of connection with the building ground is achieved.
 2. If the pedestal enclosure is mounted at a remote location, more than 25 feet away from a building or grounded AC power source, a 6-gauge bare copper grounding shall be connected from the ground lug to an appropriate grounding rod as outlined in the sections above, and in conformance with the ASIC Earth Grounding Electronic Equipment in Irrigation Systems-Guidelines:
 - a. The 6-gauge solid conductor may not exceed a minimum of an 8-inch radius bend at any point along the wire.
 - b. The 6-gauge solid conductor shall not be coiled.
 3. At this grounding point, resistance readings of 10 ohms or less are desirable, and a reading of no more than 15 ohms is required.

2.11 VALVE BOXES

- A. High density polyethylene construction with UV inhibitors. Lid shall be purple (RW) in color in turf and purple (RW) in color in shrubs, with stainless steel bolt-down mechanism. Boxes, lids, and bolts shall be from the same manufacturer.
- B. Boxes shall have an interlocking feature that locks two together when boxes are fitted bottom to bottom.
- C. Boxes shall have extra wide flange along bottom for enhanced stabilization.
- D. Boxes shall have beveled edges to prevent damage from lawn equipment.
- E. Boxes shall have extra wide flange along bottom for enhanced stabilization.
- F. Commercial grade plastic valve boxes shall be the 'VB' series manufactured by Rain Bird, or equal exactly in size and quality.

G. The lid shall be marked as follows:

1. Master Control Valve - "MV" in one inch (1") high white enamel or heat branded letters.
2. Flow Meter - "FM" or "FS" in one inch (1") high white enamel or heat branded letters.
3. Ground Rod - "GRD" in one inch (1") high white enamel or heat branded letters.
4. Remote Control Valve - "RCV" with the station number in one inch (1") high white enamel or heat branded numbers and letters.
5. Quick Coupler Valve - "QCV" in one inch (1") high white enamel or heat branded letters.
6. Mainline Isolation Shutoff Ball Valve - "BV" in one inch (1") high white enamel or heat branded letters.
7. Mainline Isolation Shutoff Gate Valve - "GV" in one inch (1") high white enamel or heat branded letters.
8. Fertigation Injector Assembly - "FERT" in one inch (1") high white enamel or heat branded letters.
9. Drip Manifold, Trees - "DRIP" in one inch (3/4") high white enamel or heat branded letters.
10. Drip Flush Valves- "FV" with the station number in one inch (1") high white enamel or heat branded letters.
11. Electrical Splice Box - "WIRE" or "ELECT" in one inch (1") high white enamel or heat branded letters.

H. Valve box sizes as noted on drawing details.

2.12 SPRINKLER HEADS AND BUBBLERS

- A. All sprinkler head types and nozzles shall be as listed on the Drawings.
- B. All pop-up sprinkler heads shall have internal check valves, and pressure regulation built into the sprinkler head, whether listed on the drawings or not.
- C. For all pop-up type sprinklers, the riser length shall be a 6" pop-up type for turf areas, 6" pop-up type for tree bubblers, and 12" pop-up type for shrub areas and 'No-Mow' bio-retention turf areas, whether listed as such on the drawings or not.
- D. Bubblers shall be as listed on the Drawings and shall be pressure compensating.

2.13 DRIP SYSTEM

- A. Provide all components required for complete system: As listed in the drawings.
 1. Screen Filter: Corrosion resistant plastic housing, 1-inch FIPT/MIPT connections with removable stainless-steel screen. The screen shall be 200 mesh. Refer to irrigation legend for manufacturer and model.
 2. Pressure regulator: Constructed of thermoplastic with stainless steel compression spring and securing screws. Pre-set to maintain constant outlet pressure of 40 psi.
 3. End Flush Valve Assembly: Manual flush valve assembly. As listed in the Drawings.

2.14 POINT SOURCE IRRIGATION

- A. Provide low-volume point-source emission devices, manufactured by GPH Products to efficiently deliver irrigation water at the plant root zone as indicated on construction plans.
- B. As listed in the Drawings. Refer to irrigation legend for manufacturer and model.
- C. Emitters shall regulate flow to 0.50, 1, 2, or 4 GPH. Refer to drawings for manufacturer, sizes, types, and quantities.
- D. Point source system accessories including PVC nipples, 1/2" check valves, PVC flex hose, poly flex hose, and PVC flex hose fittings shall be of manufacturer, model, and type as shown in the legend and as shown in the details.

2.15 MISCELLANEOUS INSTALLATION MATERIALS

- A. Solvent cement and primer for solvent weld joints shall be of make and type approved by manufacturer(s) of pipe and fittings. Cement shall be maintained at proper consistency throughout use.
- B. Pipe joint compound shall be non-hardening, non-toxic materials designed specifically for use on threaded connections in water carrying pipe. Performance shall be same as Rector Seal 100 W.
- C. Valve box drain rock: 3/4-inch washed gravel.
- D. Bedding material for mainline: Standard clean sand

2.16 MISCELLANEOUS EQUIPMENT

- A. Provide all equipment called for by the Drawings.
- B. Provide to the College, at completion of the Maintenance Period, three (3) each of all operating and servicing keys for both controller cabinets and enclosures, and wrenches required for complete maintenance and operation of all heads and valves. Include all wrenches necessary for complete disassembly of all heads and valves.
- C. Provide quantity of quick coupler keys as described in **2.3 QUICK COUPLING VALVES** above.

PART 3 - INSTALLATION

3.1 PREPARATION

- A. Schedule and coordinate placement of materials and equipment in a manner to effect the earliest completion of work in conformance with construction and progress schedule.
- B. The Contractor shall field verify the static water pressure at the project site prior to commencing work or ordering irrigation materials. If the Contractor fails to verify static water pressure prior to commencing work, Contractor shall assume responsibility for all costs required to make system operational.
- C. Examine areas and conditions under which work of this section is to be performed. Do not proceed with work until necessary conditions have been corrected.

3.2 HANDLING AND STORAGE

- A. Protect work and materials from damage during construction and storage as directed by Architect.
- B. Handle plastic pipe carefully; especially protecting it from prolonged exposure to sunlight.
- C. Store sub-surface dripline and polyethylene tubing in cool dry place out of sunlight during installation.

3.3 LAYOUT

- A. Layout work as accurately as possible in accordance with diagrammatic drawings.
- B. Where site conditions do not permit location of piping, valves and heads where shown, notify Architect immediately and determine relocation in a joint conference.
- C. Run pipelines and automatic control wiring in common trenches whenever practical.

3.4 EXCAVATING AND TRENCHING

- A. Excavation shall be in all cases ample in size to permit the pipes to be laid at the elevations intended and to permit ample space for joining.
- B. Minimum Depth of trenches shall be enough to provide minimum cover from finish grade to top of pipe in trenches, as follows:
 - 1. 18-inch minimum cover over main lines to the control valves and quick coupling valves.
 - 2. 18-inch minimum cover over direct burial control wires from controller to valves.
 - 3. 12-inch minimum cover over the lateral lines to sprinkler heads.
 - 4. 24-inch minimum cover over sleeves.
- C. For actual depth requirements refer to irrigation drawings for exact depths as determined by pipe use (mainline, under pavement, sleeving, lateral line) and pipe size.
- D. When considering depth, the Contractor shall be aware that all mainline pipe 3" and larger shall have 4 inches of surrounding backfill material.
- E. When considering depth, Contractor shall be aware that all pipe sleeves under asphalt or vehicular traffic paving shall have 4 inches of surrounding backfill material.
- F. Restore surfaces, existing underground installations, etc., damaged or cut as a result of excavations, to original conditions in a manner approved by the Architect.
- G. Where other utilities interfere with irrigation trenching and pipe work, adjust the trench depth as instructed by Architect.
- H. All Irrigation piping shall have a minimum clearance of 4 inches from other irrigation piping and the piping of other trades, or minimum of 6 inches as may be required by city or state agency. Refer to city or state agency requirements. Pipelines routed parallel shall not be installed directly over one another.

3.5 SLEEVING

- A. Extend sleeve ends a minimum of 12 inches beyond the edge of the paved surface. Cover pipe ends and mark with stakes. Route wire through and tie at each end to stakes.
- B. Where pipes or control wires pass through sleeves, provide a removable non-decaying plug at ends of sleeve to prevent entrance of earth.
- C. Contractor must provide and install sleeving for all pipe and control wiring under paving even if plans do not indicate specific locations for clarity. Sleeve shall be twice the size of pipe carried.

3.6 ASSEMBLING PVC PIPELINES

- A. All pipes shall be assembled free from dirt and pipe scale. Field cut ends shall be reamed only to full pipe diameter with rough edges and burrs removed.
- B. Solvent Weld Joint:
 - 1. Prepare joint by first making sure the pipe end is square, then deburring the pipe end and cleaning the pipe and fitting of dirt.
 - 2. Dry-insert pipe into fitting to check for mis-sizing. Pipe should enter fitting 1/3 to 2/3 depth of socket.

3. Coat the inside socket surface of the fitting and the external surface of the male end of the pipe with P-70 primer (manufactured by Weld-On), immediately followed by Weld-On 711 cement liberally applied to the male end of the pipe and lightly applied to the inside of the socket. Then, apply a second coat of cement to the pipe end.
4. Insert pipe immediately into fitting and turn it 90° to distribute cement and remove air bubbles. The pipe must seat to the bottom of the socket and fitting. Check alignment of the fitting. Pipe and fitting shall be aligned properly without strain to either.
5. Hold joint still for approximately thirty (30) seconds and then wipe the excess cement from the pipe and fitting.
6. It is very important to wipe all excess cement from the pipe and fitting. Excess cement allowed to stay in contact with pipe and fitting will weaken pipe integrity.
7. Cure joint a minimum of thirty (30) minutes before handling and at least six (6) hours before allowing water in the pipe.

C. Threaded Joint:

1. Field threading of plastic pipe or fittings is not permitted. Factory-formed threads only will be permitted.
 2. Factory-made nipples shall be used wherever possible. Field-cut threads in metallic pipe will be permitted only where necessary. When field threading, cut threads accurately on the axis with sharp dies.
 3. All threaded joints shall be made up with pipe joint compound. Apply compound to male threads only.
 4. Where assembling metallic pipe to metallic fitting or valve, no more than three (3) full threads shall show when joint is made up.
 5. Where assembling to threaded plastic fitting, take up joint no more than one full turn beyond hand tightening.
 6. Where assembling soft metal (brass or copper) or plastic pipe, use a strap type friction wrench only; do not use a metal-jawed wrench.
- D. Cap or plug openings as pipeline is assembled to prevent entrance of dirt or obstruction. Remove caps or plugs only when necessary to continue assembly.
- E. Where PVC pipe passes under paving, they shall pass through SCH 40 PVC sleeve twice the size of pipe carried. Layout work as accurately as possible in accordance with diagrammatic drawings.
- F. Where pipes or control wires pass through sleeves, provide a removable non-decaying plug (expanding foam) at ends of sleeve to prevent entrance of earth.
- G. Water Systems: Maintain 10-foot minimum horizontal separation from potable water piping. Where reclaimed and potable water pressure main line piping cross, the reclaimed water piping shall be installed below the potable water piping in a PVC Class 200 pipe sleeve which extends a minimum of 5 feet on either side of the potable water piping. Provide a minimum vertical clearance of 6 inches.

3.7 MAINLINE ISOLATION VALVES

- A. Install where shown on Drawings where practical.
- B. Locate valve box minimum 24-inches from to walk edges, buildings, or walls.
- C. Install in shrub or ground cover areas where possible.
- D. Install in a Rain Bird 12-inch (nominal) standard rectangular valve box, model VB-STD.

3.8 REMOTE CONTROL VALVES-WITHOUT FILTER ASSEMBLY

- A. Install where shown on Drawings and group together where practical. Limit one remote control valve per box with no exceptions.

- B. Locate valve boxes 12 inches from and perpendicular to sidewalk edges, buildings, walls and curbs. Provide 12 inches between valve boxes where valves are grouped together.
- C. Thoroughly flush mainline before installing the valve.
- D. Install in shrub or ground cover areas where possible.
- E. Label control line wire at each valve with a 2 1/4" x 2 3/4" polyurethane I.D. tag, indicating identification number of the valve (controller and station number). Attach a label to control wire.
- F. Install in a Rain Bird 12-inch (nominal) standard rectangular valve box, model VB-STD.

3.9 REMOTE CONTROL DRIP VALVE ASSEMBLIES

- A. Install where shown on Drawings and group together where practical. Limit one remote control valve assembly per box with no exceptions.
- B. Locate valve boxes 12 inches from and perpendicular to sidewalk edges, buildings and walls. Provide 12 inches between valve boxes where valves are grouped together.
- C. Thoroughly flush mainline before installing the valve.
- D. Install in shrub or ground cover areas where possible.
- E. Label control line wire at each valve with a 2 1/4" x 2 3/4" polyurethane I.D. tag, indicating identification number of the valve (controller and station number). Attach a label to control wire.
- F. Install assembly within two Rain Bird 20-inch (nominal) jumbo rectangular valve boxes, model VB-JMB. Lower box shall be inverted.

3.10 QUICK COUPLING VALVES

- A. Install quick coupling valves on double swing-joint assemblies of brass risers and fittings.
- B. Thoroughly flush mainline before installing the valve.
- C. Install 12-inch from hardscape areas.
- D. Install in a Rain Bird 10-inch round valve box, model VB-RND.

3.11 VALVE BOXES

- A. Install one valve box for each type of valve unless otherwise noted.
- B. Install zone valves boxes 12 inches from walk or header and 12 inches apart. Short side of rectangular boxes shall be parallel to walk or header. Install 2 inches above finish grade in groundcover areas and 1/2 inch above finish grade (sod ht.) in lawn areas.
- C. Install common bricks as shown and as required to keep box stable. Install gravel sump after compaction of all trenches.

3.12 SPRINKLER HEADS AND BUBBLERS

- A. Thoroughly flush lines before installing heads, drip tubing, or bubblers.

- B. Locate heads and bubblers as shown in the drawings and details.
- C. Set sprinkler heads perpendicular to grade unless otherwise shown.
- D. Adjust sprinkler heads for proper distribution and trim, providing complete coverage with minimal overspray.

3.13 POINT SOURCE DRIP IRRIGATION

- A. Install per irrigation details.
- B. Install flush valve(s) at a point farthest away from source along header(s). Install in Rain Bird 7-inch round valve box, model VB-7RND.

3.14 DECODER CABLE SYSTEM GROUNDING

- A. The controller shall be grounded to meet the minimum manufacturer's specification for Controller Grounding. The contractor shall be responsible for proper grounding techniques as it relates to this project installation. All grounding of the irrigation control system shall be per Electrical Code.
- B. All grounding of the irrigation control system shall be per the American Society of Irrigation Consultants; ASIC Guideline 100-2002 For Earth Grounding Electronic Equipment in Irrigation Systems. Contractor shall have said guideline available for review on the job site at all times by the Landscape Architect / Irrigation Consultant and College's Authorized Representative. Contact ASIC www.asic.com (312) 372-7090 for information on obtaining this document.
- C. Ground kit shall be provided by SiteOne Green Tech, model GRPA. The grounding circuit requires a ground rod and a ground plate (U.L. approved 5/8"x8' copper-clad steel ground rod and a U.L. approved 4"x96" copper ground plate) plus a minimum of 50 pounds of PowerSet® earth contact material.
- D. The controller unit(s) shall:
 - 1. Install the grounding cable and earth ground hardware at right angles to the two-wire path(s).
 - 2. Locate ground rods and ground plates no more than 12-15 feet from the controller.
 - 3. Separate ground rods and ground plates outside the "Sphere of Influence" zone, which is the minimum of 10 feet apart.
 - 4. Ensure that no additional cable or control wires are within the same 10 foot "Sphere of Influence" zone.
 - 5. Ground cable shall be no smaller than AWG #6. The sweep from the controller for the grounding cable will be no smaller than 1-1/2".
 - 6. Place the ground rod in a separate 10-inch round valve box to facilitate maintenance.
 - 7. Make connections with CadWeld®. No other connections shall be approved.
 - 8. Ground controller through building ground system.
- E. Decoders:
 - 1. Grounding shall occur at every 12th decoder or 450' to 500 ft. of wire, whichever comes first.
 - 2. Grounding shall occur at the last decoder in any wire run.
 - 3. Grounding plate shall be installed perpendicular to the wire path and NOT pointing towards another decoder or wire path to ensure that the lightning's energy leaving the plate does not transfer to other parts of the system.
 - 4. Make connections with CadWeld®. No other connections shall be approved.
- F. Splices shall be made with 3M DBR/Y-6 / SPEARS DS-400 connectors, or as required by decoder manufacturer.

3.15 2- WIRE DECODER CABLE GROUNDING

A. Connections to Grounding Rods and Plates.

1. The minimum ground conductor running from the grounding device to the surge arrester shall be a minimum of a 6-gauge/4.0mm diameter, bare copper wire.
2. The ground rod must be buried a minimum of 6 inches under the soil.
3. All connections to grounding rods or ground plates shall conform to ASIC Earth Grounding Electronic Equipment in Irrigation Systems-Guidelines and shall consist of CADWELD™ connections. No other connections shall be approved.
4. The resistance reading at the grounding rod/plate connector shall be less than 1 milliohm.
5. Any wire extensions required to connect from a grounding rod or plate to a surge arrester or enclosure ground lug shall be bare copper.
6. The 6-gauge solid conductor shall not exceed a minimum of an 8-inch radius bend at any point along the wire.
7. There shall only be one mechanical connection on the grounding system.
8. All mechanical connections where wires connect shall be cleaned, scored, and covered with antioxidant.
9. Wire extensions connected to grounding devices shall use an exothermic weld CADWELD™ connection. Ground hardware shall extend at right angles from the two-wire path.

B. Surge Arrester Wiring and Installation.

1. The surge arrester shall be installed in an appropriate irrigation box and shall be connected to the two-wire in accordance with the manufacturer's two-wire connector specifications.
2. The surge arrester ground wire shall be connected to a bare copper solid core ground wire using a screw clamp or split bolt type connector (no wire nuts of any kind are supported for grounding wires). The connector shall be installed and insulated according to the manufacturer's specifications.
3. The bare copper wire shall be connected to the grounding device using the grounding device specifications.
4. The first surge arrester on the two-wire path shall be within 25' of the controller.
 - a. This grounding point shall be separate from the irrigation controller's enclosure grounding point.
5. A surge arrester shall be placed every 450'-500' on the two-wire path.
 - a. In lightning prone regions, A surge arrester shall be placed every 300' rather than going out to the maximum distance.
6. A surge arrester shall be placed at the end of the two-wire that is the maximum distance from the controller or if looped at the point of maximum distance from the controller.
7. Any branch of the two-wire that exceeds 50' shall have a surge arrester at the end.
8. On an uninterrupted wire run of more than 500', a surge arrester shall be placed at each end.

C. Splices shall be made with SPEARS DS-400 connectors.

3.16 BACKFILLING

- A. Backfill only after piping has been tested, inspected and approved.
- B. Backfill material shall be the earth excavated from the trenches, free from rocks, concrete chunks, and other foreign or coarse materials. Carefully select backfill that is to be placed next to plastic pipe to avoid any sharp objects which may damage the pipe.
- C. All mainline pipe 3" and larger and/or below vehicular traffic lanes shall have 4 inches of surrounding backfill material, consisting of clean sand, on all sides of pipe.

- D. Place backfill materials in 6-inch layers and compact by tamping to a minimum compaction of 90 percent relative compaction per ASTM D1557.
- E. All pipe sleeve under asphalt or vehicular traffic paving shall have 4 inches of surrounding backfill material, consisting of clean sand, on all sides of pipe.
- F. Trenches located under areas where asphaltic concrete or concrete paving occur, shall be backfilled with sand (a layer 4 inches below the pipe and 4 inches above the pipe) and compacted in layers to 95% relative compaction per ASTM D1557, using manual or mechanical tamping devices. Trenches for piping shall be compacted to equal the compaction of the existing adjacent undisturbed soil and shall be left in a firm unyielding condition. All trenches shall be left flush with adjoining finish grade. The Contractor shall set in place, cap and pressure test all piping under paving prior to the paving work.
- G. Generally, piping under existing walks is done by jacking, boring or hydraulic driving, but where any cutting or breaking of concrete is necessary, it shall be done and replaced by the Contractor at no cost to the College. Permission to cut or break concrete shall be obtained from the College's Authorized Representative. No hydraulic driving will be permitted under concrete paving.
- H. Dress off areas to finish grades and remove excess soil, rocks or debris remaining after backfill is completed.
- I. If settlement occurs along trenches, and adjustments in pipes, valves and sprinkler heads, soil, sod or paving are necessary to bring the system, soil, sod, or paving to the proper level or the permanent grade, Contractor, as part of the work under this Contract, shall make all adjustments without extra cost to the College.

3.17 TEMPORARY REPAIRS

- A. The College reserves the right to make temporary repairs as necessary to keep the irrigation system in operating condition. The exercise of this right by the College shall not relieve the Contractor of his responsibilities under the terms of the Guarantee as herein specified.

3.18 PIPE TESTS

- A. Notify Architect at least three (3) days in advance of testing.
- B. Perform testing at Contractor's own expense.
- C. Center load piping with a small amount of backfill to prevent arching or slipping under pressure. No fitting shall be covered.
- D. Apply the following tests after all weld plastic pipe joints have cured at least 24 hours.
 - 1. Test live (constant pressure) and quick coupling valve lines WITHOUT equipment requiring attachment to the mainline hydrostatically at 125 PSI minimum. Lines shall be filled with water and pressure gauge connected to the pipeline. After lines have reached the 125 PSI, (use hydraulic pump or other safe method - do not use an air compressor) cut off the source of pressure. Lines will be approved when test pressure (with an allowable drop of 2 PSI) is maintained for a minimum of two (2) hours. Should leaks develop during the test period, they shall be located and repaired and retested in the same method. The Contractor shall make tests and repairs as necessary until test conditions are met.

2. At completion, test live (constant pressure) and quick coupling valve lines WITH ball valves, RCV's, QCV's, and other equipment requiring attachment to the mainline hydrostatically at 125 PSI minimum. Lines shall be filled with water and pressure gauge connected to the pipeline. After lines have reached the 125 PSI, (use hydraulic pump or other safe method - do not use an air compressor) cut off the source of pressure. Lines will be approved when test pressure (with an allowable drop of 4 PSI) is maintained for a minimum of two (2) hours. Should leaks develop during the test period, they shall be located and repaired and retested in the same method. The Contractor shall make tests and repairs as necessary until test conditions are met.
 3. Test lateral lines with water at line pressure and visually inspect for leaks. Retest after correcting defects.
- E. Remake faulty joints with new materials. Do not use cement or caulking to seal leaks.

3.19 SYSTEM ADJUSTMENT

- A. Adjust RCV pressure regulating modules to proper and similar pressure to provide optimum and efficient coverage.
- B. Adjust nozzle sizes, degree of arc, change out nozzles, and install pressure compensating screens as required to cover planting areas without overspray at Contractor's expense. Adjust all sprinklers to keep spray in confines of planted area. No overspray shall be allowed onto paving, buildings, or walls.
- C. Drip System Check
 1. Immediately after installation, flush lateral line piping by removing automatic flush valve, figure 8 fitting, or by opening the manual shut-off flush valve.
 2. Clean filter. Open filter flush valve for at least 10 seconds. Clean or replace clogged elements.
 3. For adjustable pressure regulators adjust pressure regulator to system design pressure.
 4. Verify that emitters are producing specified water output. If not, replace emitters, check filter element, check pressure at emitters, and review system for clogs and leaks. Correct deficiencies.
- D. Overhead Irrigation and Bubbler Check
 1. Perform coverage test in the presence of Architect to establish that coverage of all planting areas is complete and adequate.
 2. Correct deficiencies and repeat test until approved.

3.20 GUARANTEE

- A. It shall be the responsibility of the Contractor to fill and repair all depressions and replace all necessary lawn and planting due to the settlement of irrigation trenches for one year following completion and acceptance of the job.
- B. The Contractor shall also guarantee all materials, equipment and workmanship furnished by him to be free of all defects of workmanship and materials, and shall agree to replace at his expense, at any time within one year after installation is accepted, any and all defective parts that may be found.

3.21 SITE DAMAGE

- A. Repair scars, ruts, or other marks in landscaped areas caused by Irrigation Contractor.
- B. Repair all scars, gouges, and any otherwise damage to streets, sidewalks, walls, and any other hardscape or paved surfaces which are caused by Irrigation Contractor's operations, equipment, or personnel. All repairs shall be done in a manner as to return said repairs to original condition and to the Landscape Architect's and/or College's Authorized Representative's satisfaction.

3.22 CLEANUP

- A. When work of this section has been completed, and at such other times as may be directed, remove all trash, debris, surplus materials, and equipment from the site.
- B. Upon completion of work, remove from site machinery, tools, excess materials, and rubbish resulting from Contractor's operations.
- C. Clean and remove all tire marks left on paved surfaces by equipment used in Contractor operations and as directed by the Landscape Architect and/or College's Authorized Representative.
- D. Leave work areas in a neat and clean condition as accepted by the Landscape Architect and/or College's Authorized Representative. Sweep clean all paved areas.

3.23 PRE-MAINTENANCE OBSERVATION (PUNCH LIST)

- A. Irrigation Consultant shall conduct a 'Pre-Maintenance Period Walk-Through' walk with Contractor foreman and Contractor project supervisor for the purpose of observing irrigation system. The contractor shall operate each system in its entirety for the College's Authorized Representative at this time. Items deemed unacceptable by the Irrigation Consultant and/or College's Authorized Representative shall be reworked to College satisfaction.
- B. The Contractor shall provide a Controller Chart and "As-built" Drawings to the Landscape Architect 3 DAYS before the 'Pre-Maintenance Period Walk-Through' walk occurs.
- C. Irrigation Consultant may call off walk-through at their discretion if/when contractor representative is/are not available for the walk-through. The contractor shall reimburse Consultant for all travel expenses.
- D. Consultant shall provide a 'Punch List Field Report' showing items of concern and those requiring rework.

3.24 FINAL OBSERVATION PRIOR TO ACCEPTANCE

- A. The Contractor shall provide and show proof of completed punch list report before Final Walk-Through. During walk-through items deemed not acceptable by the Irrigation Consultant and/or College's Authorized Representative, shall be reworked to the College's satisfaction.
- B. Before the Final 'Walk-Through' will be conducted the Contractor shall show evidence to the College's Authorized Representative that the College has received all accessories, charts, "As-Built" Drawings, and equipment as shown in the Drawings and Specifications. May be part of the O&M Manual.
- C. Five days prior to the Final 'Walk-Through' the Contractor shall deliver the Operations and Maintenance Manual and all other submittal items to the Landscape Architect and the College's Authorized Representative for review and acceptance.
- D. Project maintenance period shall not start until the Landscape Architect accepts with approval of the complete irrigation system.

3.25 SITE VISIT OBSERVATION SCHEDULE

- A. Site visits are required for the project. Site Visits shall be conducted concurrently with the main project adjacent to this project. Refer to the Specifications for the main project adjacent to this project for the site visit schedule. The Contractor shall be responsible for notifying the Landscape Architect and the College's Authorized Representative in advance of site visits.

- B. When site visits are conducted by someone authorized other than the Irrigation Consultant or College's Authorized Representative, the Contractor shall show evidence in writing and applicable photos of site visit, and documentation of when and by whom these site visits were made.
- C. No site visits will commence without current "As-Built" Drawings.

END OF SECTION 328400

SECTION 329000 - PLANTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide planting work and planting maintenance complete as shown on the drawings and as specified including staking and layout of the landscaping, including soil sampling as required by the State of California Model Water Ordinance.
- B. Related work specified elsewhere includes:
 - 1. Section 312200, EARTHWORK AND GRADING
 - 2. Section 328400, PLANTING IRRIGATION

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. All local, municipal and state laws, codes and regulations relating to all portions of this work are to be incorporated as part of these Specifications. These specifications shall not be construed to conflict with any of the above codes, regulations or requirements. The Specifications and Drawings shall take precedence when they call for materials, workmanship or construction of a better quality or higher standard than required by the above mentioned codes and regulations. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.
 - 2. State of California Model Water Ordinance
 - 3. Public utility agency having jurisdiction over the project work.
 - 4. "Sunset Western Garden Book," Lane Publishing Co., Menlo Park, California; current edition.
 - 5. "American Standards for Nursery Stock," American Association of Nurseryman, 230 Southern Building, Washington, D.C. 20005.
 - 6. International Society of Arboriculture, Guide for Plant Appraisal, latest version.
 - 7. US Composting Council Compost Analysis Program (CAP)
 - 8. US Composting Council (USCC) Seal of Testing Assurance (STA) program.
 - 9. Test Methods for the Evaluation of Composting and Compost (TMECC)
 - 10. Manufacturer's recommendations.
- B. Qualifications:
 - 1. Experience: Assign a full-time employee to the job as foreperson for the duration of the Contract who is certified landscape technician, certification through CLCA or minimum of four (4) years experience in landscape installation and maintenance supervision, with experience or training in turf management, entomology, pest control, soils, fertilizers and plant identification
 - 2. Labor Force: Provide a landscape installation and maintenance force thoroughly familiar with, and trained in, the work necessary to complete the tasks described herein in a competent, efficient manner acceptable to the District.
- C. Requirement
 - 1. Site Visit: At beginning of work, visit and walk the site with the District's Representative to clarify scope of work and understand existing project/site conditions.
 - 2. Supervision: The foreperson shall directly supervise the work force at all times and be present during the entire installation. Notify District's Representative of all changes in supervision.
 - 3. Identification: Provide proper identification at all times for landscape maintenance firm's vehicles and a labor force uniformly dressed in a manner satisfactory to District's Representative.
 - 4. Protect all existing and new plants from construction activities, deer & rodents: Contractor shall be responsible for protection of all planting per Part 3.
- D. Plant Material Standards:

1. Quality and Size of Plants: Conform to the State of California Grading Code of Nursery Stock, No. 1 grade. Use only nursery-grown stock which is free from insect pests and diseases.
2. Comply with federal and state laws requiring inspection for plant diseases and infestations. Submit inspection certificates required by law with each shipment of plants, and deliver certificates to the District. Obtain clearance from the County Agricultural Commissioner as required by law, before planting plants delivered from outside the County in which planted.

E. Soils & Amendment Testing

1. All soils & amendments to be tested for agricultural suitability by one of the following accredited soil testing laboratories (or approved equal). Components of the test shall include all major nutrients, pH, salinity, boron, sodium, micronutrients, copper, zinc, manganese and iron, adsorption rate, organic content and texture. The laboratory report shall include recommendations for adjusting fertilizer and amendment quantities.

Waypoint Analytical, Inc.
4741 E. Hunter Ave, Suite A, Anaheim, CA 92807; (717) 282-8777

Control Laboratories
42 Hangar Way, Watsonville, CA 95076; (831) 724-5422
Perry Laboratory
424 Airport Boulevard , Watsonville, CA 95076; (831) 722-7606

Wallace Laboratories, LLC
365 Coral Circle, El Segundo, CA 02345; (310) 615-0016

- F. Upon approval of the laboratory's report by the Landscape Architect, the recommendations in the report shall become a part of the Specifications and the soil preparation procedures, quantities of soil amendment, fertilizer and other additives shall be adjusted to conform with the report at no additional cost to the owner. Note that there is a minimum quantity of organic amendment specified elsewhere in this specification section.
- G. Significant issues with soil quality will require soil to be retested in the locations identified on Soil Analysis Plan, prior to proceeding with plant installation, to ensure that the recommendations in the report have been followed and the In-Situ Topsoil is agriculturally suitable as described in Part 2.

1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms. Subsoil is defined as either existing site soil located below the topsoil prior to construction activities, or select fill used for rough grading during construction. Subsoil cannot be considered for use as planting soil.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.
- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.

- E. Planting Soil: Approved existing topsoil or imported planting soil, meeting the requirements herein. Subsoil cannot be considered for use as planting soil.

1.4 SUBMITTALS, per Section 013300.

- A. The following shall be submitted to the landscape architect for approval prior to the installation of landscape materials and products.
 - 1. Manufacturer's Technical data sheets for fertilizers, turf, and all other products and materials listed herein.
 - 2. Manufacturer's technical data sheets for amendments. Reports to be dated no more than 3 months prior to soil preparation.
 - 3. 1-pint samples of imported soils, organic amendments/compost, mulches, and stones.
- B. Submit planting soil and organic amendment laboratory reports a minimum of [3] weeks prior to beginning soil prep. See below for required soil analysis reports.
- C. Required Soil Analysis Reports. Reports to be dated no more than [3] months prior to soil preparation.
 - 1. Soil Analysis Plan: Contractor to submit annotated plan showing confirmed locations of all required soil tests. Each location is to be identified with a unique label.
 - 2. Existing Planting Soil Analysis: After approval of the Soil Analysis Plan, rough grading, and topsoil placement, contractor to obtain 3 representative samples of in situ topsoil taken from approved site locations at depth of 4" to 6" below finish grade and submit to an accredited soils testing laboratory for "agricultural suitability" analysis, including particle size, infiltration rate, and evaluation of physical and chemical properties of soil and recommendations for adding amendments and fertilizers to the soil.
 - 3. Subsoil Analysis: In addition to the above required soil samples, contractor to obtain one representative sample of any subgrade soil that is to receive a layer of imported planting soil over it. The laboratory report shall include the soil's infiltration rate, total combined silt and clay content for determining the total allowable combined silt and clay content of the imported planting soil specified herein.
 - 4. Imported Planting Soil Analysis: Contractor to submit an "agricultural suitability" analysis report from an accredited soils testing laboratory, including particle size, infiltration rate, and evaluation of physical and chemical properties of soil and recommendations for adding amendments and fertilizers to the soil. Soil to conform to requirements in Part 2.
 - 5. Amended Planting Soil Analysis: Significant issues with soil quality will require soil to be retested in the locations identified on Soil Analysis Plan, prior to proceeding with plant installation, to ensure that the recommendations in the report have been followed and the final Planting Soil is agriculturally suitable as described in Part 2.
- D. The Contractor is responsible to follow all local water ordinances and make available to the local agency the soil analysis report and verification of its implementation as required.
- E. Delivery Receipts upon request by District, provide delivery receipts for quantities of soil & amendments delivered to the site.
- F. Plant sample of each variety of plant. Samples to be delivered to the site 2 weeks prior to plant installation and stored and maintained separately from entire quantity of delivered plants. Contractor to maintain plants throughout maintenance period. Plants to be reviewed in a single site visit.
- G. Representative photos of each plant species. Photos to be of plants to be delivered to site and not a stock photograph.
- H. Entire plant quantity delivered to the site. Plants to be reviewed prior to installation during a single site visit.

- I. Representative photos of each tree species (unless trees previously tagged at nursery by landscape architect). Photos to be of trees to be delivered to site and not a stock photograph.

1.5 WARRANTY AND REPLACEMENT

- A. Maintenance Period: See Part 3.
- B. Warrant the work against weed growth for a period of four (12) months after application of Pre-Emergence Weed Killer.
- C. Warrant all plants to be in a healthy, thriving condition until the end of the maintenance period, and deciduous trees, shrubs and vines beyond that time until active growth is evident.
- D. Replace all dead and damaged plants and plants not in a vigorous condition immediately upon discovery and as directed by the District's Representative and at no cost to the owner. Install replacement plants before the final acceptance of the maintenance period in the size specified.
- E. Warrant all products, prepared soils and plant material installed and maintained by contractor against defects for a period of one year after final acceptance of the maintenance period.

PART 2 - PRODUCTS

2.1 SUBSOIL

- A. Submit soil analysis report from an approved soil/s laboratory for approval by the Landscape Architect. Refer to Part 1 for soil testing requirements.

2.2 EXISTING PLANTING SOIL (ON-GRADE):

- A. Existing Planting Soil is defined as on-site topsoil that is either to be removed and stockpiled for reuse or to remain in place during construction. Satisfactory planting soil shall be free of subsoil, clay, lumps, stones, and other objects over 4" in diameter, and without weeds, roots, and other objectionable material. The soil shall be fertile, friable, natural, productive soil containing a normal amount of humus, and shall be capable of sustaining healthy plant life. Soil shall not be infested with nematodes or with other noxious animal life or toxic substances. Soil shall be obtained from well-drained, arable land, and shall be of an even texture. Soil shall not be taken from areas on which are growing any noxious weeds such as morning glory, equisetum, or Bermuda grass, etc.
- B. If herbicide contamination is suspected then a radish/ryegrass growth trial must be performed. Consult with Landscape Architect prior to decision to test or not.
- C. Amended Planting Soils are to conform with the following target levels. Elements are expressed as mg/kg dry soil or mg/l for saturation extract.

pH value	6.5-7.9,	iron	4-15 mg/kg
lime	none present	manganese	0.6-3.0 mg/kg
salinity (ECe)	0.5-3 milli-mho/cm	zinc	1-3 mg/kg
chloride	<150 ppm	copper	0.2-3.0 mg/kg
nitrate	20-30 ppm	boron	0.2-0.5 mg/kg
SAR	<3	magnesium	25-100 mg/kg
phosphorus	8-20 mg/kg	sodium	<200 mg/kg
potassium	60-180 mg/kg	sulfur	25-100 mg/kg

- D. If sufficient on-site surface topsoil is not available, contractor to provide imported planting soil as specified below. Placement of dissimilar soils shall be coordinated with irrigation zones by the contractor to maintain separate valves for dissimilar soils.
- E. Submit soil analysis report from an approved soils laboratory for approval by the Landscape Architect. Refer to Part 1 for soil testing requirements.

2.3 IMPORTED PLANTING SOIL (ON-GRADE):

- A. Imported planting soil shall be screened and shall be free of subsoil, heavy or stiff clay, rocks, gravel, brush, roots, weeds, noxious seeds, sticks, trash, and other deleterious substances.
- B. Imported Planting Soils are to conform with the following target levels. Elements are expressed as mg/kg dry soil or mg/l for saturation extract.

pH value	6.5-7.9,	iron	4-15 mg/kg
lime	none present	manganese	0.6-3.0 mg/kg
salinity (ECe)	0.5-3 milli-mho/cm	zinc	1-3 mg/kg
chloride	<150 ppm	copper	0.2-3.0 mg/kg
nitrate	20-30 ppm	boron	0.2-0.5 mg/kg
SAR	<3	magnesium	25-100 mg/kg
phosphorus	8-20 mg/kg	sodium	<200 mg/kg
potassium	60-180 mg/kg	sulfur	25-100 mg/kg

- C. The silt and clay content of Imported Planting Soil shall not exceed that of the existing soil it is to be placed over. Except where otherwise required, it shall be a "Sandy Loam" as classified in accordance with USDA Standards with a combined total of between 25% to 40% Clay and Silt.
- D. Submit soil analysis report from an approved soils laboratory for approval by the Landscape Architect. Refer to Part 1 for soil testing requirements.
- E. Following approval of the sample, provide a one-half cubic yard sample, which shall be stored at the site of work for comparison with sample and subsequent loads of soil. The comparison sample shall be protected by a cover until the installation of all soil has been completed and accepted.

2.4 PLANTING SOIL FOR STORMWATER TREATMENT

- A. Planting soil for stormwater treatment shall be used in landscape areas designed for infiltration and the filtration of stormwater runoff before entering the storm drain system as specified below and as shown in drawings.
- B. Planting soil mixes for stormwater treatment are available from TMT Enterprises in San Jose, CA, (408-432-9040); American Soil and Stone in Richmond, CA (510-292-3000) and San Rafael, CA (415-456-1381); and Lyngso Garden Materials in Redwood City, CA, (650-364-1730); or approved equal.
- C. Planting soil for stormwater treatment shall conform to the following:
 1. All material shall be free of trash and debris, expansive clays or any other deleterious materials
 2. Material shall be free of seeds.
 3. The mineral component shall be classified as USDA sand or loamy sand and shall conform to the following particle size and characteristics.

US Sieve	Size (mm)	Class	% wt. retained
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#10	2.0	Gravel	0-10
#35	2.0-0.5	coarse sand 20-35	
#270	<0.05	Silt & Clay	6-12

Rock ½ inch – 1 inch = 0-5% by volume with none > 1 inch
 Organic = 0-3% by weight

4. Percolation Rate must fall in the range of 10 inches per hour Initial Rate and 5 inches Sustained Rate as determined by SPL method A06-2, unless otherwise specified by civil engineer.
5. Chemistry Suitability Considerations
 - a. Salinity: Saturation Extract Conductivity (ECe) Less than 3.0 dS/m @ 25° C.
 Sodium: Sodium Adsorption Ratio (SAR) Less than 6.0
 Boron: Saturation Extract Concentration Less than 1.0 ppm
 Reaction: pH of Saturated Paste: 5.5 – 7.8 without high lime content.
 - b. Top 6" should be amended with the approved organic composted yard waste. See Part 3 for amendment procedures.
- D. Submit Soil analysis report(s) for approval by the Landscape Architect and Civil Engineer. Refer to Part 1 for soil testing requirements.
 1. Submit soil analysis report (including infiltration rate) for planting soil mix for stormwater treatment from an approved soils laboratory.
 2. Submit subsoil analysis report (including infiltration rate) for subsoils if planting area is designed to allow stormwater to infiltrate into native subsoils.

2.5 ORGANIC AMENDMENT FOR PLANTING SOILS (ON-GRADE):

- A. Ground Redwood or Ground Fir Bark with the following properties:

Percent Passing Sieve	Designation
100	9.51 mm 3/8"
50-60	6.35 mm 1/4"
20-40	4.76 mm No. 4
0-20	2.38 mm No. 8 8 mesh

Redwood Sawdust

Dry bulk density, lbs. per cu. yd.	260-280
Nitrogen stabilized - dry weight basis	0.4% minimum
Salinity (ECe):	4.0 maximum
Organic Content:	90% minimum
Reaction (pH):	4.0 minimum

Ground Fir and/or Pine Bark

Dry bulk density, lbs. per cu. yd.	350 minimum
Nitrogen stabilized - dry weight basis,	0.5% minimum
Salinity (ECe):	4.0 maximum
Organic Content:	90% minimum
Reaction (pH):	4.0 minimum

- B. **Submit sample, product's technical data sheet, and analysis report** from an approved soils laboratory for approval by the Landscape Architect. The analysis report should include compliance to the specifications above and directions for product use.
- C. Contractor may use Composted Yard Waste Amendment in lieu of the above specified Organic Amendment pending approval of product' technical data sheet.

2.6 COMPOSTED YARD WASTE AMENDMENT FOR PLANTING SOILS (ON-GRADE):

- A. The above ORGANIC AMENDMENT FOR PLANTING SOILS (ON-GRADE) is the specified organic amendment material. Acceptance of Composted Yard Waste Amendment in lieu of the above specified amendment material will be considered if the in situ planting soil salinity and soil structure is favorable for the inclusion of recycled yard waste organic matter, as approved by the Landscape Architect.
- B. Composted yard waste amendment **will not** be accepted for use in on-structure raised planters and pots.
- C. The composted yard waste amendment shall be a mixture of feedstock materials including green material consisting of chipped, shredded, or ground vegetation and mixed food waste, or clean processed recycled wood products. Single source, biosolids (sewage waste) compost will not be acceptable.
- D. The addition of the compost shall result in a final ECe of the amended soil of less than 4.0 dS/m @ 25 degrees C. as determined in a saturation extract. Use the following table to determine the maximum allowable Ece (dS/m of saturation extract) of compost at desired use rate and allowable Ece increase.

DESIRED USE RATE		MAXIMUM ALLOWABLE Ece INCREASE FROM AMENDMENT		
Cu. Yds. Amendment Per 1000 Sq. Ft. for Incorporation to 6" depth	Volume percentage of amendment	1 dS/m	2 dS/m	3 dS/m
		Maximum ECe of Compost		
1	5	14	28	42
2	11	7	14	21
3	16	5	9.5	14
4	22	3.5	7	10.5
5	27	3	5.5	8.5
6	32	2.5	4.5	7

Example: Specification calls for 6 cu. Yrds. Compost per 1000 sq. ft. for incorporation to 6" depth, and site soil has an ECe of 2.0. In order to avoid exceeding ECe of 4 in final blend, compost ECe shall be less than 4.5 dS/m.

- E. Composted Yard Waste Soil Amendment properties to conform to the following:
 1. Gradation:

% Passing by weight	Sieve Designation
85-100	9.51 mm
50-80	2.38 mm
0-40	500 micron
 2. Organic Content: Minimum 50% based on dry weight and determined by ash method. Minimum 250 lbs. organic matter per cubic yard of compost.
 3. Carbon to nitrogen ratio: Maximum 35:1 if material is claimed to be nitrogen stabilized.
 4. pH: 5.5 – 8.0 as determined in saturated paste.
 5. Soluble Salts: See D. above.
 6. Moisture Content: 35-60%.
 7. Contaminants: The compost shall be free of contaminants such as glass, metal and visible plastic. Heavy meals, fecal coliform and Salmonella shall not exceed levels outlined as acceptable in the California integrated waste management regulations.
 8. Maturity: Physical characteristics suggestive of maturity include:
 - Color: Dark brown to black.
 - Acceptable Odor: None, soil-like, or musty.
 - Unacceptable Odor: Sour, ammonia or putrid.
 - Particle Characterization: Identifiable wood pieces are acceptable, but the balance of the material shall be soil-like without recognizable grass or leaves.

- F. Submit sample, product's technical data sheet, and analysis report from an approved soils laboratory for approval by the Landscape Architect. The analysis report should include compliance to the specifications above, directions for product use, and a list of ingredients. It is the Contractor's responsibility to secure test of the proposed composted yard waste amendment (2 quart sample) and submit to a Soils Laboratory for evaluation and recommendations. The composted yard waste amendment sample shall be a grab sample from the currently available material that has been tested within the last 30 days and shall include the composter's Compost Technical Data Sheet that includes lab analytical test results and directions for product use along with list of ingredients. Refer to Part 1 for soil testing requirements.
- G. Based on the Soils Laboratory evaluation, the addition of composted yard waste amendment **shall not be** acceptable if it creates a leaching requirement.

2.7 PLANTS

- A. Plant the variety, quantity and size indicated on drawings. The total quantities indicated on the drawings are considered approximate and furnished for convenience only. Contractor shall perform plant quantity calculations and provide all plants shown on the drawings.
- B. Measure trees and shrubs with branches in normal position. Height and spread dimensions indicated refer to the main body of the plant, and not from branch tip to tip.
- C. Take precautions to ensure that the plants will arrive at the site in proper condition for successful growth. Protect plants in transit from windburn and sunburn. Protect and maintain plants on site by proper storage and watering.
- D. Install healthy, shapely and well rooted plants with no evidence of having been root-bound, restricted or deformed.
- E. Tag plants of the type or name indicated and in accordance with the standard practice recommended by the American Association of Nurserymen.
- F. Substitutions will not be permitted, except as follows:
 - 1. If proof is submitted to the Landscape Architect that any plant specified is not obtainable, a proposal will be considered for use of nearest equivalent size or variety with an equitable adjustment of contract price.
 - 2. Substantiate and submit proof of plant availability in writing to the Landscape Architect within 10 days after the effective date of Notice to Proceed.
- G. Tree Form
 - 1. Trees shall have a symmetrical form as typical for the species/cultivar and growth form.
 - 2. Central Leader for Single Trunk Trees: Trees shall have a single, relatively straight central leader and tapered trunk, free of co-dominant stems and vigorous, upright branches that compete with the central leader. Preferably, the central leader should not have been headed; however, in cases where the original leader has been removed, an upright branch at least ½ the diameter of the original leader just below the pruning point shall be present.
 - 3. Potential Main Branches: Branches shall be evenly distributed radially around and appropriately spaced vertically along the trunk, forming a generally symmetrical crown typical for the species.
 - 4. Headed temporary branches should be distributed around and along the trunk as noted above and shall be no greater than 3/8" diameter, and no greater than ½ diameter of the trunk at point of attachment.
- H. Tree Trunk
 - 1. Trunk diameter and taper shall be sufficient so that the tree will remain vertical without the support of a nursery stake.
 - 2. Trunk shall be free of wounds (except properly-made pruning cuts), sunburned areas, conks (fungal fruiting-bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers and/or lesions.

3. Tree trunk diameter at 6" above the soil surface shall be within the diameter range shown for each container size below, except where shown otherwise:

Container	Trunk Diameter	Soil level from Container Top
gallon	0.5" to 0.75"	1.25 to 2"
gallon	0.75" to 1.0"	1.75 to 2.75"
Box	1.5" to 2.5"	2.25 to 3"
Box	>2.5"	2.25 to 3"
Box	>2.5"	3-6"

4. Tree trunks shall be undamaged and uncut with all old abrasions and cuts completely callused over. Do not prune plants prior to delivery.

I. Tree Roots

1. Trunk root collar (root crown) and large roots shall be free of circling and/or kinked roots. Contractor may be required to remove soil near the root collar in order to verify that circling and/or kinked roots are not present.
2. The tree shall be well rooted in the container. When the trunk is lifted the trunk and root system shall move as one and the rootball shall remain intact.
3. The top-most roots or root collar shall be within 1" above or below the soil surface. The soil level in the container shall be within the limits shown in above table.
4. The rootball periphery shall be free of large circling and bottom-matted roots.
5. On grafted or budded trees, there shall be no suckers from the root stock.

2.8 TURF GRASS

- A. Turf Sod: Blends as follows:

Tall Fescue Sod Mix (Grown on Sand)
 90 to 95% Dwarf-type Fescue and Tall-type Fescue
 10% to 20% Blue Grass
 Available from Delta bluegrass (800) 637-8873

2.9 FERTILIZERS

- A. General Landscape Fertilizers:

1. Commercial fertilizer, pelleted or granular form, conform to the requirements of Chapter 7, Article 2, of the Agricultural Code of the State of California for fertilizing materials as follows:
 - a. Type A: 6% Nitrogen, 20% Phosphorus Acid and 20% Potash, (6-20-20)
 - b. Type B: 21 gram planting tablets 20% Nitrogen, 10% Phosphoric Acid and 5% Potash (20-10-5) available from Agriform or 10gm BestPacks packets 20% Nitrogen, 10% Phosphoric Acid and 5% Potash (20-10-5) available from Best Fertilizer Co.
 - c. Type C (Maintenance Fertilizer): Complete fertilizer 21% Nitrogen, 7% Phosphoric Acid and 14% Potash (21-7-14).

- B. If commercial fertilizer having the above analysis is not obtainable, other similar commercial fertilizer may be used providing it meets the approval of the Landscape Architect.

- C. Sod Fertilizer
 Provided by grower.

- D. Sod Fertilizer:
Provided by grower.

- E. Hydroseed Fertilizer
Hydroseed fertilizer to be used in the slurry shall be commercial fertilizers conforming to the requirements of the California Food and Agricultural Code, shall have a guaranteed analysis for nitrogen, phosphorus and potassium of 7-2-1. Products specified as slow release shall have been tested and demonstrate a nearly linear curve.

2.10 IRON SULFATE

- A. Dry form.

2.11 EROSION CONTROL NETTING

- A. New, with a uniform, open plain-weave, flame-retardant mesh. The mesh shall be [natural brown-tan] and made from unbleached single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than one-half its normal diameter. Furnish jute mesh in rolled strips to meet the following requirements:
1. Width: 48 inches, with a tolerance of one-inch wider or narrower.
 2. Not less than 78 warp ends per width.
 3. Not less than 41 weft ends per yard.

2.12 PERFORATED DRAIN PIPE

- A. Polyvinyl Chloride (PVC) pipe and pipe fittings shall meet extra strength minimum of SDR-35 of the requirements of ASTM Specification D3034.
- B. Perforated and non-perforated corrugated polyethylene pipe, 3- to 10-inch diameter, shall meet the requirements of ASTM D883 and ASTM F412, and shall conform to Section 68 of the Standard Specifications.
- C. Corrugated polyethylene pipe fittings shall comply with all requirements of AASHTO M-252-851 for 3- to 10-inch diameter pipe. Couplings shall be split or snap-on type for perforated pipe and split couplings with gaskets for non-perforated pipe. Cutting pipe with integral couplings will not be allowed.
- D. Corrugated polyethylene pipe and fittings manufactured by Advanced Drainage Systems, Inc., shall be considered the standard to determine compliance to this specification.
- E. Inspection Tube Cap: Paint cap one coat chocolate-brown color using Flat, exterior grade latex paint as accepted by District's Representative.

2.13 FILTER FABRIC / PERMEABLE LANDSCAPE FABRIC

- A. Polyester or polypropylene non-woven filter fabric with uniform fiber distribution by "Terra Bond" #1115, "Mirafi, Inc." #140N, or approved equal.

2.14 PERMEABLE DRAIN ROCK

- A. Permeable drain rock used in subsurface drain installations to be Class 2 permeable material in conformance with Section 68 "Subsurface Drains" of the Standard Specifications; gradation to 3/4" maximum size. Submit Sample for approval.

2.15 ROOT BARRIER

- A. UB 18-2 as manufactured by Deep Root Corporation (800) 458-7668, Root Solutions, Inc. (800) 554-0914, or equal. Install a minimum of 6 panels/16 linear feet centered on each tree, where tree is within 8 feet of sidewalk, paving, or utilities.
- B. Geomembrane Root barrier at utilities: Bamboo Barrier Geomembrane as manufactured by Deepproot. Install per manufacturer's recommendation. Install a minimum of 15' centered on tree.
 - 1. Thickness: 0.060" For utilities within 5' of tree
 - 2. Thickness: 0.030"- 0.040" For utilities beyond 5' from tree

2.16 LANDSCAPE EDGING

- A. Metal Edge Restraints: Subject to conformance with requirements, available manufacturer that offer product that may be incorporated into the Work includes, but not limited to DuraEdge paving restraint edging for straight and curvilinear borders at planting areas, as manufactured by J.D. Russell Company, or equal, (800) 888-7425, www.jdrussellco.com.
 - 1. Comply with ASTM A1011, hot-rolled, standard flexible, carbon steel landscape edging, fabricated in sections with stake pockets stamped, punched or welded to face of section approximately 30 inches apart to receive stakes.
 - 2. Size: 5-inches wide.
 - 3. Thickness: 1/4 inch.
 - 4. Color: Black
 - 5. Length: 16 feet.
 - 6. Connection method: Double staked at overlap joints and designed to receive tapered steel stakes.
 - 7. Finish: Hot dipped galvanized finish to be applied after steel landscape edging is cut to length and stake pockets are stamped, punched or welded. Galvanization shall comply with ASTM A123/A123M-97A. Zinc coverage shall be to a standard thickness of 3.3 mil.
 - 8. Edging Stakes: Steel, tapered, 16 inches minimum length or more to secure, and finished to match specified steel landscape edging.
 - 9. Standard start/end sections, 90 degree corners, and splicers as required.

2.17 PRE-EMERGENCE WEED KILLER

- A. Clean non-staining as recommended by a licensed pest control specialist.

2.18 TREE STAKES

- A. Lodge pole pine logs, clean, smooth, un-treated.
- B. Unless otherwise shown on drawings, provide two-inch (2") diameter by eight feet (8') long for trees less than 8' high and 1" caliper.
- C. Unless otherwise shown on drawings, provide three-inch (3") diameter by eight to ten feet (8' - 10') long for trees greater than 8' high and 1" caliper.
- D. Provide 3 stakes per tree

2.19 TREE TIES

- A. Unless otherwise shown on drawings, provide rubber strap, 24-inch minimum length without sharp edges adjacent to trunk, V.I.T. cinch-tie, Dublin, CA, (818)882-9530, or approved equal.
- B. Black corded rubber tree ties w/ clips by greensleeves.com

- C. Biodegradable VStrap webbing by Treestrap.

2.20 TREE GUYING SYSTEM:

- A. For trees up to 3" caliper, 3/16" galvanized steel cable, with rubber tree collar, 12" minimum long, and secured with cable clamp, and attached to anchor for below-grade location, Duckbill Model 40 DTS, or approved equal.
- B. For trees 3" to 6" caliper, 3/16" galvanized steel cable with rubber tree collar, 18" minimum long, and secured with cable clamp, 3" take-up eye to eye turnbuckle, and attached to anchor for below-grade location, Duckbill Model 68 DTS, or approved equal.
- C. Rootball guying system with three dead man anchors per tree as shown on drawings.

2.21 MULCH

- A. Organic Mulch:
 - 1. Rail Yard Walk-On Bark
- B. Rock Mulch:
 - 1. Hard, durable smooth, river washed stone, 3/4-inch to 1-inch diameter in grey color range, Lin Creek or equal.
- C. Submit samples of rock mulch for approval by Landscape Architect until acceptable to District, at no extra cost.

2.22 STONES

- A. Stone Maintenance Rock: Smooth 1"-3" grey river rock, Lin Creek or equal. Match existing campus rock.
- B. Smooth 3"-8" Stones grey river rock, Lin Creek or equal to be installed around Drainage Structures to prevent mulch from migrating into stormdrain, and where shown in drawings

PART 3 - EXECUTION

3.1 PLANT PROTECTION AND REPLACEMENT

- A. Inspect and protect all existing and new plants and trees against damage from construction activities, erosion, trespass, insects, rodents, deer, disease, etc. and provide proper safeguards, including trapping of rodent and applying protective sprays and fencing to discourage deer browsing. Maintain and keep all temporary barriers erected to prevent trespass.
- B. Repair all damaged planted areas. Replace plants and re-seed or re-sod turf immediately upon discovery of damage or loss.

3.2 TOPSOIL STRIPPING AND STOCKPILING

- A. Strip existing planting soil to whatever depths encountered in areas that may be compacted due to construction activities and in a manner to prevent intermingling with the underlying subsoil or other objectionable material. Topsoil stripping is limited to area outside "Drip Line" of existing trees to remain and areas indicated on drawings and as approved by the District's Representative.
- B. Remove heavy growths of grass from areas before stripping.

- C. Stockpile existing planting soil in storage piles in areas shown, or where designated by District. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent windblown dust.
- D. If herbicide contamination is suspected then a radish/ryegrass growth trial must be performed. Consult with Landscape Architect prior to decision to test or not.

3.3 LIME TREATED SOIL

- A. If site work includes Lime Treatment of the subsoil, the Contractor shall remove full depth of treated soil beyond 12" from structure(s) and replace with approved planting soil.
- B. Following removal of lime treated material, scarify subgrade to a minimum depth of 6 inches and test for drainage.
- C. Test subgrade in all planting areas for drainage by flooding with minimum 4-inch depth of water puddle and verify complete absorption of standing water within two hours. If standing water is still present after two hours, provide perforated pipe and drain rock "French Drain" system in bottom of non-draining planters and connect to storm drainage system, as accepted by District's Representative prior to backfilling with approved planting soil.

3.4 GENERAL PREPARATION OF PLANTING SOIL

- A. Submit soil analysis report of amended soils from an approved soils laboratory for approval by the Landscape Architect. Refer to Part 1 for soil testing requirements.
- B. All planting soils to be amended as specified in soil laboratory analysis report(s).
- C. Provide a minimum of 12" depth of amended planting soil in all planting areas, or more where shown or specified otherwise. Install soil in maximum 12" lifts. Compact each lift prior to installing subsequent lifts.
- D. Thoroughly wet down the planting areas to settle the soil and confirm irrigation coverage and operation. Allow soil to dry so as to be workable as described herein.
- E. After the rototill work, float areas to a smooth, uniform grade as indicated on the drawings. Slope all planting areas to drain. Roll, scarify, rake and level as necessary to obtain true, even planting surfaces. Remove rocks, sticks and debris 1 inch and larger in size in turf areas and 2 inches or larger in shrub and ground cover areas. Secure approval of the grade by the Landscape Architect before any planting.
- F. Prior to planting, soil shall be loose and friable to a minimum depth of 12" with a relative maximum compaction of 85%. Rip and scarify any overly compacted and re-compacted planting areas (in two directions full depth of compacted soil) prior to planting.
- G. Water settling, puddling, and jetting of soil and backfill materials as a compaction method is not acceptable.
- H. Prior to planting, soil shall be moist, but not so moist that it sticks to a hand shovel. Do not work planting soil in a wet or muddy condition or dump or spread in areas where subgrade is not in proper condition.
- I. Provide planting soil as a final lift in all planting areas within and adjacent to paved areas and other construction where native site soil has been covered by engineered fill and/or base rock. Unless otherwise shown or specified, finish grade in planting islands shall be crowned with a minimum 2% pitch to drain.

- J. Finish Grade: Hold finish grade and/or mulch surface in planting areas 1/2-inch below adjacent pavement surfaces, tops of curbs, manholes, etc. The subgrade of the mulch in mulched planting areas shall be a minus 2 inches at a distance of 12 to 18 inch from the edge of pavement. Drag finish grade to a smooth, even surface. Grade to form all swales and berms. Pitch grade with uniform slope to catch basins, streets, curb, etc., to ensure uniform surface drainage. Areas requiring grading include adjacent transition areas that shall be uniformly sloped between finish elevations. Slope surface away from walls so water will not stand against walls or buildings. Control surface water to avoid damage to adjoining properties or to finished work on the site. Take required remedial measures to prevent erosion of freshly graded areas.
- K. Planting operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped until conditions are satisfactory.

3.5 PREPARATION OF IN-SITU PLANTING SOIL

- A. In-Situ Planting Soil is defined as top soil left in its original place and undisturbed during construction activities which is to receive new planting
- B. Except within tree driplines, rip all planting areas in two directions full depth to a minimum of **[12"]** into undisturbed native subsoil prior to amending. Scarification of any planting area which cannot be accomplished with a tractor shall be accomplished by an alternative method approved by the District's Representative to the specified depth to ensure proper percolation/drainage.
- C. Inspect planting areas and remove all base rock and other foreign material. Verify placement of planting soil within dripline of trees with District's Representative.
- D. Test depth of loose soil with hand shovel in presence of District's Representative in several locations as directed.
- E. After acceptance of the planting condition, uniformly mix and amend soil with required fertilizers, nutrients, etc. per specifications herein and recommendations given in soils reports.
- F. In the case of a contradiction between the quantity of organic amendment required by the soils laboratory analysis and the specified quantity below, the greater of the two quantities shall take precedence. Spread organic amendment, iron and Type A fertilizer evenly over installed and rough graded on-site topsoil in all planting areas including turf, ground cover and shrub areas at the following rates:
 - 1. Organic Amendment: 6 cubic yards per 1,000 square feet
 - 2. Fertilizer: Type A (6-20-20) at 20 lbs. per 1,000 square feet.
 - 3. Iron Sulfate: 10 lbs. per 1,000 square feet
- G. Rototill above additives into soil 8-12" inches deep. Keep iron sulfate off pavement and other surfaces to prevent rust staining. Correct all rust damage to work.
- H. Final planting soil shall have a pH range of 6.5 to 7.5.

3.6 PREPARATION OF IMPORTED PLANTING SOIL (ON-GRADE)

- A. Uniformly distribute and spread Subsoil or select fill in planting areas to achieve rough grading and compact to a maximum of 85% relative compaction.
- B. Except within tree driplines, rip all planting areas in two directions full depth to a minimum of 12" into undisturbed native subsoil prior to backfilling. Scarification of any planting area which cannot be accomplished with a tractor shall be accomplished by an alternative method approved by the District's Representative to the specified depth to ensure proper percolation/drainage.
- C. Thoroughly water-settle subsoil to required subgrade prior to installing Top Soil.

- D. Prior to placing planting soil secure the District's Representatives acceptance of the planting areas subgrade condition. Test depth of loose soil with hand shovel in presence of District's Representative in several locations as directed.
- E. After acceptance of the planting areas subgrade condition, uniformly distribute and spread planting soil backfill over scarified subgrade in planting areas as specified.
- F. Mix and amend soil with required fertilizers, nutrients, etc. per specifications herein and recommendations given in soils reports.

3.7 SOIL PREPARATION FOR STORMWATER TREATMENT PLANTING AREAS

- A. Earthwork, rough grading, and drainage materials shall be complete and approved prior to installation of planting soil.
- B. Do any necessary finish grading in addition to that performed in accordance with earthwork to bring subgrades after final compaction to required grades and sections as indicated.
- C. Install the approved specified soil mix for infiltration planting areas as shown in Drawings. Soil depth to be 18" minimum typical and 24" minimum for planting areas with trees, unless otherwise shown on drawings.
- D. After placement of the mineral component, the top 6" should be blended with the approved compost for stormwater treatment planting areas. If bulk blended, proportions should be 1 part compost to 4 parts of the above mineral component. If blended in place, this is equivalent to 4 ½ cubic yards or 1,000 square feet for blending to 6-inch depth
- E. If organic content of the mineral component is less than 0.6% weight, then it should be blended with compost in volume proportions of 5% compost to 95% mineral.
- F. Finish Grade: Provide a smooth, even surface. Sideslopes of stormwater planting areas (eg. bioswales, basins, etc) not to exceed 3:1 in any direction. Finish grade of flow through planters to be as shown in drawings.

3.8 WEED GERMINATION

- A. Work shall be done under the supervision of a person licensed by the State of California as a pest control applicator and holding a qualified applicator license or a Qualified Applicator Certificate.
- B. Following soil preparation and fine grading of planting areas, irrigate the planting areas to germinate any weed seeds for a minimum period of 21 days. Maintain the soil in a damp condition for a minimum depth of 4 inches. Following approval of the weed germination by the District's Representative, spray kill the weeds using a short lived systemic weed killer that will not affect subsequent planting. Confirm the weed kill and allow the soil to dry out to optimum degree for planting prior to planting.

3.9 PRE-EMERGENCE WEED KILLER

- A. Work shall be done under the supervision of a person licensed by the State of California as a pest control applicator and holding a qualified applicator license or a Qualified Applicator Certificate.
- B. Apply pre-emergence weed killer in all areas to receive ground cover planting. Obtain approval of the finish grades prior to applying weed killer and coordinate planting and watering with the pest control specialist prior to planting. Take care to keep weed killer off areas to be seeded.

3.10 ROOT BARRIER

- A. Install in continuous sheet parallel and adjacent to curb or pavement edge as required on drawings and in accordance with manufacturer's recommendations. Set top of barrier approximately ½-inch above finished soil surface to allow concealment with mulch, as accepted by District's Representative

3.11 BAMBOO RHIZOME BARRIER

- A. Install in linear fashion along and adjacent to the edges of the planting area as detailed or, if not shown, in accordance with manufacturer's recommendations. Overlap at joints minimum 12" using double stick tape as recommended by barrier manufacturer. Set top of barrier approximately 2-inches above finished soil surface to allow concealment with mulch, as accepted by District's Representative.

3.12 EROSION CONTROL NETTING

- A. Verify finished grades and provide Jute Mesh and single grind Redwood bark mulch on all slopes 3:1 and steeper as accepted by the District's Representative. Install jute mesh loosely up and down the slope in accordance with manufacturer's specifications and as follows. Fit the soil surface contour and hold in place with 12-inch long, 11-gauge (minimum) steel wire staples driven vertically into the soil at 18- to 24-inch spacing. Jute mesh strips shall overlap along all edges at least 6 inches. Ends of side strips shall be buried into the soil at least 6 inches. Drive staples along edges to securely anchor mesh to ground.

3.13 ALUMINUM EDGING

- A. Install as shown in drawings in continuous strips as indicated and in accordance with manufacturer's recommendations with stakes spaced 48 inches on center maximum and at all joints.

3.14 HEADER BOARD

- A. Install in continuous, smooth alignment as indicated with stakes spaced 48 inches on center maximum and at all joints.

3.15 TREE AND SHRUB PLANTING

- A. Mark tree and shrub locations on site using stakes, gypsum or similar approved means and secure location approval by the Landscape Architect before plant holes are dug. Adjust location as required prior to planting.

- B. Review location of plants in relationship to irrigation heads and adjust location(s) that interfere with the function of the spray heads. Adjust locations as required to ensure that the plant roots receive the proper amount of water in order for the plants to thrive.

- C. Square Tree Pits

- 1. Drilled tree pits shall be modified to a square pattern with pit walls scarified to promote root penetration.

- D. Excavate tree, shrub and vine pits as follows:

	<u>Width</u>	<u>Depth</u>
Boxed Trees	Box + 24"	Box depth
Canned Trees (15 gc)	Can + 18"	Can depth
Canned Shrubs/Vines (1- 5 gc)	Can + 12"	Can depth

- E. Test drainage of plant beds and tree pits by filling with water (minimum 6"). The retention of water in planting beds and plant pits for more than two (2) hours shall be brought to the attention of the Landscape Architect. If rock, underground construction work, tree roots, poor drainage, or other obstructions are encountered in the excavation of plant pits, alternate locations may be selected by Landscape Architect.

- F. Break and loosen the sides and bottom of tree pits to ensure root penetration and water test hole for drainage as required above.
- G. Excavate plant hole or tree pit keeping excavated planting soil layer on the surface when backfilling around the plant. Carefully set plants as detailed without damaging the rootball. Superficially cut edge roots vertically on three sides. Remove bottom of plant boxes before planting. Remove sides of boxes after positioning the plant and partially backfilling.
- H. Set plants in backfill with top of the rootball 1 inch above finished grade of adjacent soil. Backfill remainder of hole and soak thoroughly by jetting with a hose and pipe section. Water backfill until saturated the full depth of the hole.
- I. Backfill plant holes with mix as specified, free from rocks, clods or lumpy material. Backfill native soil free of soil amendments under rootball and foot tamp to prevent settlement. Backfill remainder of the hole with soil mix and place plant tablets or packets (Type B fertilizer) 3 inches below finish grade and 1/2-inch from roots at the following rates:

gallon can plant	-	1 tablet or packet
5 gallon can plant	-	3 tablets or packet
15 gallon can plant	-	6 tablets or packet
24-inch box plant	-	6 tablets or packet
36-inch box plant	-	8 tablets or packet

- J. Except for acid loving plants (Azaleas, Rhododendrons, Ferns, Camellias, etc.), use a soil mix of 2 parts soil from the hole, and 1 part amendment with iron added at the following rates:

gallon can plants	-	iron, 1/4 cup
5 gallon can plants	-	iron, 1/3 cup
15 gallon can plants	-	iron, 1/2 cup
24" box and larger	-	iron, 1 cup

For acid loving plants (Azaleas, Rhododendrons, Ferns, Camellias, etc.), mix 1 part soil from the hole and 1 part amendment to use a backfill around the plants.

Mix the iron, amendment and soil thoroughly for use in the top 8 inches of backfill around plants. For acid loving plants, mixture to be 1/2 soil from the hole and 1/2 amendment.

- K. Remove any soil from top of plant rootballs and secure Landscape Architect's approval of rootball height prior to mulching.
- L. After approval of rootball height, install mulch as required below.
- M. Stake and/or guy trees as detailed. Drive stake(s) until solid (at least 12" beyond bottom of rootball) and remove excess stake protruding above top tree tie to prevent rubbing against branches. Avoid driving stakes through rootball. If subgrade does not accept stakes to a stable degree, delete stakes and guy the trees as specified herein and as detailed. Locate tree ties to avoid contact with tree branches. Locate top tie at tree flex point.
- N. Build watering basin berms around trees and shrubs to drain through rootball. Basins are not required around trees in turf areas. Water backfill until saturated the full depth of the hole.

3.16 GROUND COVER PLANTING

- A. Plant in neat, straight, parallel and staggered rows as indicated on plan. Plant first row one-half required ground cover spacing behind adjacent curbs, structures, or other plant bed limits. Plant ground cover to edge of water basins of adjacent trees and shrubs.

3.17 SODDED TURF

- A. Install sod to patch and repair existing turf area due to re-grading or other construction activities.
- B. Lightly roll surface and re-shape to level humps and hollows. Secure Landscape Architect's approval prior to sodding. Do not sod on dry soil.
- C. Lay first strip of sod along a straight line (use a string in irregular areas). Butt joints tightly, do not overlap edges. On second strip, stagger joints. Use a sharp knife to cut sod to fit curves, edges and sprinkler heads.
- D. When a conveniently large area has been sodded, water lightly to prevent drying. Continue to sod and to water until installation is complete.
- E. After laying all sod, roll lightly to eliminate irregularities and to form good contact between sod and soil. Avoid a heavy roller and excessive initial watering.
- F. Thoroughly water the completed sod surface to at least 8 inches deep. Repeat sprinkling at regular intervals to keep sod moist at all times until rooted. After sod is established, decrease frequency and increase amount of water per application.
- G. Protect turf areas by erecting fences, barriers and signs necessary to prevent trespass. Keep barriers neat and well maintained.

3.18 MULCH

- A. Except where rock mulch is required, mulch all tree, shrub and ground cover areas with organic mulch to a 3-inch depth, except mulch to 2-inch depth where planting with ground cover plants from flats.
- B. Hold bark mulch away from base (trunk) of plant 4" or as directed by the Landscape Architect.
- C. Individual trees and/or shrubs planted in non-irrigated areas shall, at minimum, receive bark mulch over their watering basin and berm.
- D. No mulch is required around trees in turf areas.
- E. Install rock mulch to depth as detailed, minimum 2-inches for full coverage of soil surface, whichever is greater.

3.19 WATERING

- A. Water all trees, shrubs and ground cover immediately after planting. Apply water to all plants as often and in sufficient amount as conditions may require to keep the plants in a healthy vigorous growing condition until completion of the Contract. Provide supplemental hand watering of trees and shrubs, as required, to maintain a moist root zones throughout plant establishment period.

3.20 PRE-MAINTENANCE PERIOD REVIEW AND APPROVAL OF PLANTING

- A. Maintain plants from time of delivery to site until final acceptance of landscape installation.
- B. Receive approval of the installed planting prior to commencement of planting establishment maintenance period. Notify the Landscape Architect or District's Representative a minimum of seven (7) days prior to requested review. Before the review, complete the following:
 - 1. Complete all construction work.

2. Present all planted areas neat and clean with all weeds removed and all plants installed and appearing healthy.
3. Plumb all trees and tree and shrub supports.
4. No partial approvals will be given.

3.21 PLANTING ESTABLISHMENT MAINTENANCE

A. General Requirements

1. Maintenance Period: The planting establishment maintenance period required shall be **one year** after all planting and irrigation is complete, turf is installed/seeded, and as approved by District's representative. A longer period may be required if the turf is not thick, vigorous and even and has been mowed a minimum of 4 times, or if the plant material is not acceptably maintained during the maintenance period. The start of the maintenance period to be confirmed by District's representative. Contractor to notify landscape architect of start and end dates of maintenance period. The maintenance period may be suspended at any time upon written notice to the Contractor that the landscaping is not being acceptably maintained, and the day count suspended until the landscape is brought up to acceptable standards as determined by the District Representative.
2. Planting establishment maintenance immediately follows, coincides with, and is continuous with the planting operations, and continues through turf installation, and after all planting is complete and accepted; or longer where necessary to establish acceptable stands of thriving plants.
3. Protect all areas against damage, including erosion, trespass, insects, rodents, disease, etc. and provide proper safeguards. Maintain and keep all temporary barriers erected to prevent trespass.
4. Keep all walks and paved areas clean. Keep the site clear of debris resulting from construction or maintenance activities.
5. Repair all damaged planted areas, and replace plants and resod turf immediately upon discovery of damage or loss.
6. Check sprinkler systems at each watering; adjust coverage and clean heads immediately. Adjust timing of sprinkler controller to prevent flooding.
7. Maintain adequate moisture depth in soil to ensure vigorous growth. Check rootball of trees and shrubs independent of surrounding soils and hand water as required.
8. Keep contract areas free from weeds by cultivating, hoeing or hand pulling. Use of chemical weed killers will not relieve the Contractor of the responsibility of keeping areas free of weeds at all times.

B. Tree and Plant Maintenance

1. Maintain during the entire establishment period by regular watering, cultivating, weeding, repair of stakes and ties, and spraying for insect pests. Prune when requested by the Landscape Architect.
2. Keep watering basins in good condition and weed-free at all times.
3. Replace all damaged, unhealthy or dead trees, shrubs, grasses, vines and ground covers with new stock immediately; size as indicated on the drawings.

C. Palm Tree Maintenance

1. Do not over water palm trees. Do not use a predetermined watering schedule for the palms. Use a soil probe to determine optimum soil moisture level within the rootball.
2. Palm Tree Fertilizing: After palms show new frond growth, approximately 6 to 8 weeks after planting, apply specified balanced fertilizer with trace elements. Repeat application after 3 to 4 months. Established palms shall be fertilized spring and fall.
3. Check palms for plumb and re-plumb as required.
4. Check palms periodically for Penicillium Rot and Fusarium Wilt. If the apical bud has fallen over (Penicillium Rot symptom) or Fusarium Wilt is suspected, remove the affected tree immediately.
5. Reapply broad-spectrum fungicide labeled for landscape use on soil borne diseases for Palms as noted herein under Palm Tree Planting.

D. Turf Maintenance:

1. Maintain during the entire establishment period. Cut as frequently as growth of grass requires. Cut to a height of two inches (2"), unless otherwise directed by the Landscape Architect.
2. Maintain constant moisture to a depth of eight inches (8").

3. Trim edges of turf at paving and headerboards at time of second cutting, and at each later cutting.
4. Keep a 2-foot diameter area at tree trunk free of turf at all times to serve as a mowing band. Do not create low area around base of tree.
5. Keep turf areas free of undesirable weeds and grasses by the application of suitable selective weed killers or hand pulling.
6. Re-sod any turf areas damaged by construction activities as soon as evident.
7. Repair any gaps, hollow, settled or eroded areas by filling, rolling and re-sodding.

E. Fertilizing:

1. Upon approval and after submitting fertilizer delivery tags, maintenance fertilization shall begin 30 days after planting is complete. Fertilize all turf and ground cover areas by broad-casting Type C (21-7-14) fertilizer at the rate of 5 lbs. per 1,000 square feet evenly throughout. Reapply every forty-five (45) days until acceptable.
2. During the winter, for quick turf greening effect, calcium nitrate (15.5-0-0) may be applied at the rate of 6 lbs. per 1,000 square feet.
3. Early spring and fall substitute a complete fertilizer such as 15-15-15 applied at the rate of 6 lbs. per 1,000 square feet, to help insure continuing adequate phosphorus and potassium.
4. Apply ammonium sulfate fertilizer as necessary to maintain vigorous, green grass between fertilizations mentioned above.
5. Observe plant's color, and if a soil pH imbalance is suspected, take soil samples and obtain laboratory analysis for confirmation. Take necessary action recommended in laboratory analysis such as top dressing with soil sulfur, leaching soil, etc.

3.22 FINAL PLANTING REVIEW AND ACCEPTANCE

- A. At the conclusion of the Maintenance Period, schedule a final review with the District, the District's maintenance person, and/or the Landscape Architect. On such date, all project improvements and all corrective work shall have been completed. If all project improvements and corrective work are not completed, continue the planting establishment maintenance period at no additional cost to the District until all work has been completed. This condition will be waived by the District under such circumstances wherein the District has granted an extension of time to permit the completion of a particular portion of the work beyond the time of completion set forth in the Agreement.
- B. Submit written notice requesting review at least 10 days before the anticipated review.
- C. Prior to review, weed and restore all planted areas, mow and edge turf, plumb trees and tree supports, clear the site of all debris and present in a neat, orderly manner.

END OF SECTION

SECTION 331000 - WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes general requirements, products, and methods of execution relating to on-site domestic water and fire water systems serving all buildings and appurtenances. Unless otherwise noted, this section does not apply to irrigation water systems and water systems inside and within 5 feet of buildings. This section applies to:
1. Domestic water distribution and services.
 2. Fire water distribution and services.
 3. Water storage tanks.
- B. Contractor shall provide all labor, equipment, materials, and testing services unless otherwise noted.
- C. Related Sections:
1. Section 31 23 33 – TRENCHING, BACKFILLING, AND COMPACTING.
 2. Section 26 42 00 – CATHODIC PROTECTION
- D. Water pressure data:
1. Provided by: [Xxxxx]
 2. Testing Date: [Month Year]
 3. Location: [FH #, intersection, or address]
 4. Static Pressure: [xx.x] psig
 5. Residual Pressure: [xx.x] psig
 6. Flow: [x,xxx] gpm
 7. Orifice Size: [2.5 inch]
 8. Contractor shall notify Engineer if actual water pressure encountered varies by ± 10 psig.

1.2 SUBMITTALS

- A. Comply with requirements of Section 01 33 00 – SUBMITTAL PROCEDURES.
- B. Product Data: Manufacturer's literature and data, including, where applicable, sizes, pressure rating, rated capacity, listing/approval stamps, labels, or other marking on equipment made to the specified standards for materials, and settings of selected models, for the following:
1. Piping and fittings.
 2. Gaskets, couplings, sleeves, and assembly bolts and nuts.
 3. Gate valves and ball valves.
 4. Blow-off valves, air release and vacuum valves, and combination air valves.
 5. Check valves.
 6. Pressure reducing valves.
 7. Backflow preventers.
 8. Valve boxes, frames and covers.
 9. Water meter boxes, frames and covers.
 10. Post indicators.
 11. Fire department connections and wet stand pipes.
 12. Fire hydrants.
 13. Thrust block concrete mix and/or restrained joints and fittings.
 14. Tapping sleeves and tapping valves.
 15. Service saddles and corporation stops.
 16. Identification materials and devices.
 17. Corrosion protection.
 18. Water sampling stations.

- C. Shop Drawings and Calculations: Where an on-site fire water system is required, Contractor shall provide shop drawings for engineer and agency approval prior to construction. Coordinate with the Contract Documents and identify any proposed modifications or deviations. Shop Drawings and Calculations shall be stamped and signed by a registered Fire Protection Engineer licensed by the State of California.
1. Include the following information:
 - a. Design assumptions.
 - b. Thrust block sizing and calculations.
 - c. Materials to be used.
 - d. Available water pressure.
 - e. Required water pressure.
 2. The review of fire system components constitutes only a portion of the review and approval required. A copy of the fire system component submittal package shall be forwarded by the Contractor to the Local Fire Authority for further review and approval.

1.3 QUALITY ASSURANCE

- A. Comply with the latest edition of the following Standards and Regulations:
1. American Water Works Association (AWWA) and American National Standards Institute (ANSI):
 - a. C104/A21.4 ANSI Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - b. C105/A21.5 ANSI Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - c. C110/A21.10 ANSI Standard for Ductile-Iron and Gray-Iron Fittings, 3 inch - 48 inch for Water.
 - d. C111/A21.11 ANSI Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - e. C115/A21.15 ANSI Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - f. C116/A21.16 ANSI Standard for Protective Fusion-Bonded Epoxy Coatings Interior & Exterior Surfaces for Ductile-Iron and Gray-Iron Fittings.
 - g. C150/A21.50 ANSI Standard for Thickness Design of Ductile-Iron Pipe.
 - h. C151/A21.51 ANSI Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - i. C153/A21.53 ANSI Standard for Ductile-Iron Compact Fittings for Water Service.
 - j. C500 Metal-Seated Gate Valves for Water Supply Service.
 - k. C502 Dry-Barrel Fire Hydrants.
 - l. C503 Wet-Barrel Fire Hydrants.
 - m. C504 Rubber-Seated Butterfly Valves.
 - n. C507 Ball Valves, 6 inches - 48 inches.
 - o. C508 Swing-Check Valves for Waterworks Service, 2 inches - 24 inches NPS.
 - p. C509 Resilient-Seated Gate Valves for Water Supply Service.
 - q. C510 Double Check Valve Backflow Prevention Assembly.
 - r. C511 Reduced-Pressure Principle Backflow Prevention Assembly.
 - s. C512 Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
 - t. C550 Protective Epoxy Interior Coating for valves and Hydrants.
 - u. C600 Installation of Ductile-Iron Water Mains and their Appurtenances.
 - v. C602 Cement- Mortar Lining of water Pipelines in place- 4 inches and larger.
 - w. C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
 - x. C651 Disinfecting Water Mains
 - y. C652 Disinfection of Water-Storage Facilities
 - z. C800 Underground Service Line Valves and Fittings for 1/2 inches - 2 inches.
 - aa. C900 Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 inches - 12 inches, for Water Distribution.
 - bb. C901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2 inches through 3 inches, for Water Service.
 - cc. C905 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inches - 48 inches.
 - dd. C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 inches - 63 inches, for Water Distribution and Transmission.
 - ee. C907 Polyvinyl Chloride (PVC) Pressure Fittings for Water, 4 inches - 8 inches.

- ff. C908 PVC Self-Tapping Saddle Tees for Use on PVC Pipe.
- gg. D103 Factory-Coated Bolted steel Tanks for water Storage.
- 2. National Fire Protection Association (NFPA):
 - a. NFPA 13 Standard for the Installation of Sprinkler Systems.
 - b. NFPA 14 Standard for the Installation of Standpipe, Private Hydrants, and Hose Systems.
 - c. NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection.
 - d. NFPA 22 Standard for Water Tanks for Private Fire Protection.
 - e. NFPA 24 Private Service Mains and their Appurtenances.
 - f. NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- 3. Uni-Bell Plastic Pipe Association (UNI).
 - a. PUB 3 PVC Pipe – Technology Serving the Water Industry.
 - b. PUB 7 External Corrosion of Underground Water Distribution Piping Systems.
 - c. PUB 8 Tapping Guide for AWWA C900 Pressure Pipe.
 - d. PUB 9 Installation Guide for PVC Pressure Pipe.
 - e. B-8 Recommended Practice for the Direct Tapping of Polyvinyl Chloride (PVC) Pressure Water Pipe (Nominal Diameters 6-12 inch).
- 4. American Society of Testing and Materials (ASTM).
 - a. ASTM A536 Standard Specification for Ductile Iron Castings.
 - b. ASTM A674 Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
 - c. ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - d. ASTM D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe.
 - e. ASTM D2466 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - f. ASTM D2564 Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 - g. ASTM D2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
 - h. ASTM D3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
 - i. ASTM D3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
 - j. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 - k. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - l. ASTM F1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
 - m. ASTM F1056 Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings.
 - n. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - o. ASTM A795 Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
 - p. ASTM A865 Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints.
 - q. ASTM B88 Standard Specification for Seamless Copper Water Tube.
- 5. American Society of Mechanical Engineers (ASME).
 - a. ASME B16 series for valves, fittings, flanges, and gaskets applicable for use in water systems.
 - b. ASME B1.20.1 American Standard Tapered Pipe Threads for factory-threaded pipe and pipe fittings.
- 6. National Sanitation Foundation (NSF).
 - a. NSF/ANSI 14 Plastics Piping System Components and Related Materials.
 - b. NSF/ANSI 61 Standard for Drinking Water Systems Components – Health Effects.
- 7. Underwriters Laboratories, Inc. (UL).
 - a. UL 157 Standard for Safety for Gaskets and Seals.
 - b. UL 194 Standard for Safety for Gasketed Joints for Ductile-Iron Pipe and Fittings for Fire Protection Service.
 - c. UL 213 Rubber Gasketed Fittings for Fire-Protection Service.

- d. UL 246 Standard for Safety for Hydrants for Fire-Protection Service.
 - e. UL 262 Standard for Safety for Gate Valves for Fire-Protection Service.
 - f. UL 312 Standard for Safety for Check Valves for Fire-Protection Service.
 - g. UL 405 Standard for Safety for Fire Department Connections.
 - h. UL 448 Standard for Safety for Pumps for Fire-Protection Service.
 - i. UL 789 Standard for Safety for Indicator Posts for Fire-Protection Service.
 - j. UL 860 Pipe Unions for Flammable and Combustible Fluids and Fire-Protection Service.
 - k. UL 1091 Standard for Safety for Butterfly Valves for Fire-Protection Service.
 - l. UL 1285 Pipe and Couplings, Polyvinyl Chloride (PVC), for Underground Fire Service.
 - m. UL 1468 Direct Acting Pressure Reducing and Pressure Restricting Valves.
 - n. UL 1478 Standard for Safety for Fire Pump Relief Valves.
 8. FM Global (FM).
 - a. FM 1020 Automatic Water Control Valves.
 - b. FM 1045 Waterflow Detector Check Valves.
 - c. FM 1110 Indicator Posts.
 - d. FM 1111 Post-Indicator-Valve-Assembly.
 - e. FM 1112 Indicating Butterfly Valves.
 - f. FM 1120 and FM 1130 Fire Service Water Control Valves (OS&Y and NRS Type Gate Valves).
 - g. FM 1210 Swing Check Valves.
 - h. FM 1221 Backflow Preventers (Reduced Pressure Principle and Double Check Valve Types).
 - i. FM 1311 Centrifugal Fire Pumps (Horizontal, Split-Case Type).
 - j. FM 1312 Centrifugal Fire Pumps (Vertical-Shaft, Turbine Type).
 - k. FM 1319 Centrifugal Fire Pumps (Horizontal, End Suction Type).
 - l. FM 1361 Water Pressure Relief Valve.
 - m. FM 1362 Pressure Reducing Valves.
 - n. FM 1371 Centrifugal Fire Pumps (In-Line Type).
 - o. FM 1510 Fire Hydrants (Dry Barrel Type) for Private Fire Service.
 - p. FM 1511 Fire Hydrants (Wet Barrel Type) for Private Fire Service.
 - q. FM 1530 Fire Department Connections.
 - r. FM 1610 Plastic Pipe & Fittings for Underground Fire Protection Service.
 - s. FM 1620 Pipe Joints & Anchor Fittings for Underground Fire Service Mains.
 9. Plastics Pipe Institute (PPI).
 - a. Underground Installation of Polyethylene Pipe.
 - b. Polyethylene Joining Procedures.
 - c. Inspections, Test and Safety Considerations.
 10. American Association of State Highway and Transportation Officials (AASHTO) for H20 Loading.
 11. American Concrete Institute (ACI).
 - a. ACI 348 - Meter Pit Construction.
 12. City of Livermore] Standard Specifications and Details.
 13. Livermore – Pleasanton Fire Department.
 14. Other authorities having jurisdiction.
- B. System Description: Grades and elevations are to be established with benchmarks referenced on Plans.
- C. Comply with City of Livermore Standards and authorities having jurisdiction for the installation and testing of potable water piping and fire protection systems.
- D. Comply with City of Livermore Standards and authorities having jurisdiction for the installation, testing and separation requirements of recycled/reclaimed water piping and fire protection systems.
- E. All testing of systems specified in this section shall be witnessed by representatives of the local water department or local authority. Provide at least 7 days notice.

PART 2 - PRODUCTS

2.1 PIPING

- A. Water Distribution Main (pipe size 4 inches and larger).
1. Ductile Iron Pipe (DIP): Pressure Class 350 pipe conforming to AWWA/ANSI C151/A21.5, cement-mortar lining conforming to AWWA/ANSI C104/A21.4, with standard thickness per AWWA/ANSI C150/A21.50. U.S. Pipe, American Cast Iron Pipe Company (ACIPCO), or approved equivalent.
 - a. Flanged ends shall conform to AWWA/ANSI C115/A21.15.
 - b. Rubber-gasket joints shall conform to AWWA/ANSI C111/A21.11.
 2. Polyvinyl Chloride Pipe (PVC): Pressure Class 235, DR 18, spigot and gasket bell end, conforming to AWWA C900 or AWWA C905, with equivalent cast-iron pipe outer diameter (O.D.). J-M Manufacturing, PW Pipe, North American Pipe Company, or approved equivalent.
 3. Polyethylene Pipe (PE): PE 4710, ASTM F714, Pressure Class 200, DR 9, conforming to AWWA C906, or approved equivalent.
- B. Water Service Line (pipe size 3 inches and smaller)
1. Copper (Cu): Provide Type K soft or hard copper pipe conforming to ASTM B88.
 2. High Density Polyethylene Pipe (HDPE): PE4710, Pressure Class 200, DR 9 conforming to AWWA C901. J-M Manufacturing PIPE or approved equivalent.
- C. Recycled/Reclaimed Water piping shall be purple.

2.2 FITTINGS, GASKETS, COUPLINGS, SLEEVES, AND ASSEMBLY BOLTS AND NUTS

- A. For DIP: Provide fittings with pressure rating greater than or equal to that of the pipe. Provide flanged joints, mechanical joints, push-on joints, and insulating joints where indicated. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends. Provide mechanically coupled type joints using a sleeve-type mechanical coupling where indicated. Provide ends of pipe and fittings suitable for the specified joints. Fittings shall have cement-mortar lining conforming to AWWA/ANSI C104/A21.4.
1. Flanged Joints: Provide bolts, nuts, and gaskets in conformance with AWWA/ANSI C115/A21.15. Flanged fittings shall conform to AWWA/ANSI C110/A21.10 or C153/A21.53.
 - a. Provide flange for set screwed flanges of ductile iron, ASTM A536, Grade 65-45-12, and conform to the applicable requirements of ASME B16.1, Class 250.
 - b. Provide setscrews for set screwed flanges of 190,000 psi tensile strength, heat treated and zinc-coated steel.
 - c. Gaskets for set screwed flanges shall conform to the applicable requirements for mechanical-joint gaskets specified in AWWA/ANSI C111/A21.11.
 - d. Design of set screwed gaskets shall provide for confinement and compression of gasket when joint to adjoining flange is made.
 - e. Unless otherwise required, above ground flange assembly bolts shall be standard hex-head, cadmium plated machine bolts with American Standard Heavy, hot-pressed, cadmium plated hexagonal nuts. Buried flange nuts and bolts shall be as above except they shall be of Type 304 stainless steel.
 2. Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets shall conform to AWWA/ANSI C111/A21.11.
 3. Push-on Joints: Provide shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly conforming to AWWA/ANSI C111/A21.11. Modify bell design fittings, as approved.
 4. Insulating Joints: Provide a rubber-gasketed or other suitable approved type of insulating joint or dielectric coupling which will effectively prevent metal-to-metal contact at the joint between adjacent sections of dissimilar metals.
 - a. Provide joint of the flanged type with insulating gasket, insulating bolt sleeves, and insulating washers.
 - b. Provide gasket of the dielectric type, full face, as recommended in AWWA/ANSI C115/A21.15.
 - c. Provide bolts and nuts as recommended in AWWA/ANSI C115/A21.15.
 - d. Fittings shall be epoxy lined and coated with a thickness not less than 6-mils.
- B. For PVC: Fittings shall be DIP or PVC.

1. DIP fittings: Provide gray-iron or ductile-iron conforming to AWWA/ANSI C110/A21.10, with cement-mortar lining conforming to AWWA/ANSI C104/A21.4, and standard thickness, with equivalent cast-iron pipe O.D.
 - a. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except the bell design shall be modified, as approved, for push-on joint suitable for use with PVC plastic pipe.
 - b. Provide push-on joints, compression joints and mechanical joints where indicated between pipe and fittings, valves, and other accessories.
 - c. Mechanical joints, glands, bolts and nuts, and gaskets shall conform to AWWA/ANSI C111/A21.11.
 - d. Fittings shall be epoxy coated with a thickness not less than 6-mils.
 2. PVC fittings: Provide fabricated PVC fittings for pressure pipe conforming to AWWA C900, C905, or C907.
 - a. PVC fittings shall conform to ASTM D2466.
 - b. Push-on joints shall conform to ASTM D3139.
 - c. Compression joints shall conform to ASTM D3139.
 - d. Provide each joint connection with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets shall conform to ASTM F477.
- C. For PE: Fittings shall conform to AWWA C901 or AWWA C906. Driscopipe, or approved equivalent.
1. Socket type fittings shall conform to ASTM D2683.
 2. Butt fusion fittings shall conform to ASTM D3261.
 3. Electrofusion fittings shall comply with ASTM F1055.
- D. For Cu:
1. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18.
 2. Wrought copper solder-joint pressure fittings or wrought copper alloy unions shall conform to ASME B16.22
 3. Cast copper alloy flare fittings shall conform to ASME B16.26.
 4. Wrought copper alloy body, hexagonal stock, metal-to-metal seating surfaces, and solder-joint threaded ends shall conform to ASME B1.20.1.
 5. Compression connections shall be Mueller 110, Ford or approved equivalent.
- E. For HDPE:
1. Cast Copper Fittings shall conform to ASME B16.18.
 2. Cast Copper Compression Fittings and connections shall be Mueller 110 Ford or approved equivalent.
 3. HDPE Fittings shall conform to PE4710, Pressure Class 200, DR 9 conforming to AWWA C901. Walseley Industrial Group or approved equivalent.

2.3 GATE VALVES AND BALL VALVES

- A. Gate Valves: Valves shall open by counterclockwise rotation of the valve stem. Provide valves with ends as appropriate for the adjoining pipe.
1. Stuffing boxes shall have O-ring stem seals. Provide stuffing boxes bolted and constructed so as to permit easy removal of parts for repair.
 2. Valves (2-1/2 inches and larger):
 - a. Provide valves conforming to AWWA C500 or AWWA C509 and of one manufacturer. Valves shall have a non-rising stem, a 2-inch square nut, and double-disc gates. Valves shall be rated for 250 psi maximum working pressure. Mueller 2360 series, ACIPCO, or approved equivalent.
 - b. For the domestic water system, valves shall also conform to ANSI/NSF 61.
 - c. For the fire water system, valves 2 inches through 16 inches in size shall also conform to UL 262 and FM 1120 or FM 1130 to a working pressure of 200 psi.
 3. Where a post indicator is shown, provide valve with an indicator post flange.
- B. Ball Valves: Valves shall open by counterclockwise rotation of the valve stem. Provide valves with ends as appropriate for the adjoining pipe.
1. Valves (2-inches and smaller):

- a. Provide valves conforming to AWWA C800 and of one manufacturer. Mueller 300 Series, Ford, or approved equivalent.
2. Provide valve with operating nut or handle as shown on the Construction Documents.

2.4 BLOW-OFF VALVES, AIR RELEASE AND VACUUM VALVES, AND COMBINATION AIR VALVES

- A. Blow-off valves: Provide valve and service size as shown in the Contract Documents. Provide 2-inch valves at low points of the piping system, and 4-inch valves at dead-ends of the piping system, unless otherwise directed by the Engineer.
1. 2-inch blow-off shall have a 2-inch vertical female iron pipe (FIP) inlet and a 2-inch normal pressure and temperature (NPT) nozzle outlet with cap. Valve shall open by counterclockwise rotation of a top-mounted 9/16-inch square operating nut. All working parts shall be serviceable without excavation. Kupferle/Truflo Model TF550, or approved equivalent.
 2. 4-inch blow-off shall have a 4-inch vertical FIP inlet and a 4-inch male iron pipe (MIP) outlet with cap. Valve shall open by counterclockwise rotation of a top-mounted 9/16-inch square operating nut. All working parts shall be serviceable without excavation. Kupferle/Truflo Model TF800, or approved equivalent.
- B. Air release and vacuum valves: Provide valve and service size as shown on the Contract Documents, and where there is an increase in the downward slope or a decrease in the upward slope of the piping system. Valve shall have cast-iron single valve body, and shall conform to AWWA C512. A compound lever system shall have a maximum operating pressure of 300psi. Provide a protective cap for the outlet of the valve. Provide universal air-vacuum type valves, Crispin Model UL, Apco, or approved equivalent.
- C. Combination air valves: Provide valve and service size as shown on the Contract Documents, and at high points and sharp changes in gradient of the pipe system. Valve shall have cast-iron single valve or double valve body, and shall conform to AWWA C512. A simple or compound lever system shall have a maximum operating pressure of 300psi. Provide a protective cap for the outlet of the valve. Crispin Model C, Apco, or approved equivalent.

2.5 CHECK VALVES

- A. Valves: Valves shall have clear port opening and a cast-iron body. Provide spring-loaded or weight-loaded valves where indicated on the Construction Documents.
1. For the domestic water system, provide swing-check type valves conforming to AWWA C508. Provide valves of one manufacturer. Mueller, Apco, or approved equivalent.
 2. For the fire water system, provide swing-check type valves conforming to FM 1210 and UL 312. Mueller, Watts, or approved equivalent.

2.6 PRESSURE REDUCING VALVES

- A. Pressure Reducing Valves: Valves shall have a cast-iron body, conforming to ASTM A536, with epoxy interior coating conforming to AWWA, and rated to Pressure Class 300. Cla-Val Model 90-01, Singer, or approved equivalent.
1. Valves shall have flanged ends.
 2. Valves sized 3-inches or smaller may have screwed ends.

2.7 POST INDICATORS

- A. Posts Indicators shall withstand up to 900 ft-lbs of operating torque, be free-standing, and tamper-proof.
- B. Post Indicators shall conform to UL 789 and FM 1110. Mueller, ACIPCO, or approved equivalent.
- C. Post indicators on recycled/reclaimed systems shall be painted purple.

2.8 VALVE BOXES, METER BOXES, FRAMES AND COVERS

- A. Water Valve Box: Provide pre-cast concrete valve box for each buried valve. Provide box with steel or cast iron traffic cover marked "WATER." Christy Model G5 with G5C cover or approved equivalent.
- B. Valve or Meter Boxes: Contractor shall verify box size required for water system appurtenances as shown in the Contract Documents. Provide a precast concrete utility box for each buried appurtenance. Provide a traffic-rated lid for H2O loading. A non-traffic rated lid may be used for boxes located in landscape areas. Christy, or approved equivalent.
- C. Valve boxes, meter boxes, frames and covers on recycled/reclaimed systems shall be purple.

2.9 BACKFLOW PREVENTERS

- A. Provide backflow preventers as shown on the Contract Documents. Subject to local water department approval. Backflow preventers on the fire water system shall be subject to approval by the local office of the Fire Marshal.
- B. Reduced Pressure Principle Assemblies (RPPA): Provide a cast-iron body RPPA consisting of two independently operating check valves with a pressure differential relief valve located between the two check valves, two shut-off valves and four test cocks. RPPA shall be tamper-proof and conform to AWWA C511. Febco LF860, Watts, or approved equivalent.
- C. Double Check Detector Assemblies (DCDA): Provide a cast-iron body DCDA consisting of mainline double check assemblies in parallel with a bypass double check and meter assembly, two shut-off valves and four test cocks. DCDA shall be tamper-proof and conform to AWWA C510. Febco LF856, Watts, or approved equivalent.
- D. Backflow preventers on recycled/reclaimed systems shall be painted purple.

2.10 FIRE DEPARTMENT CONNECTIONS AND WET STAND PIPES

- A. Fire Department Connections (FDC): Provide FDC's with 2-1/2 inch female hose connections, sidewalk or free-standing type. Number of inlets shall be as shown on the Contract Documents. Clapper and spring check inlets shall each have a minimum capacity of 250 gpm, and be furnished with Knox FDC plug. Outlet shall be sized for simultaneous use of all inlets. Connection shall be branded "AUTO SPKR".
 - 1. 2-Way FDC: Connection shall conform to UL 405 or FM 1530. Elkhart, Croker, or approved equivalent.
 - 2. 3-Way FDC: Connection shall be subject to approval by the local water department or fire marshal. Elkhart, Croker, Potter-Roemer or approved equivalent.
 - 3. 4-Way FDC: Connection shall conform to UL 405. Potter-Roemer, Croker, or approved equivalent.
 - 4. 6-Way FDC: Connection shall be subject to approval by the local water department or fire marshal. Croker, Potter-Roemer or approved equivalent.
- B. Wet Stand Pipes (WSP): Provide 2-Way WSP's with valves and two (2) 2-1/2 inch male hose connections free-standing type, with a 4" inlet. Each outlet shall each have a minimum capacity of 250 gpm, and be furnished with a Knox cap. Water to the WSP shall be controlled with a remote valve. Connection shall be branded "HYDRANT." Subject to approval by the local water department or fire marshal. Croker, Elkhart, Potter-Roemer or approved equivalent. Fire department connections and wet stand pipes on recycled/reclaimed systems shall be painted purple.

2.11 FDC AND WET STAND PIPE CAPS AND PLUGS

- A. Provide Knox caps or plugs for all new FDC and wet-stand pipes included in the project. Coordinate the number of Knox keys as well as the key signage location with the local Fire Marshal.

2.12 FIRE HYDRANTS

- A. Provide two 2-1/2 inch and one 4-1/2 inch outlets with a 6-inch nominal inside diameter inlet and break-away type bolts. Hydrant shall have a working pressure of 250 psi and shall conform to AWWA C502 or C503, and be UL listed and FM approved. Provide hydrants of one manufacturer. Clow 800 series, Mueller, ACIPCO, or approved equivalent, subject to approval by the local water department and Fire Marshal. Hydrants on recycled/reclaimed systems shall be painted purple. Dry barrel hydrants shall be Mueller Company Super Centurion 200, or approved equivalent.

2.13 THRUST BLOCKS AND PIPE RESTRAINTS

- A. Blocks: Provide thrust blocks in accordance with NFPA 24 Standards. Use concrete conforming to ASTM C94 having a minimum compressive strength of 2,500 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2-1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.
- B. Pipe Restraints: Provide thrust restraint systems for fittings and joints as required or as indicated on the Plans.
 - 1. For mechanical joint fittings and joints: Pipe restraints shall be "Mega-Lug" pipe restraint system by EBBA Iron, Inc., or approved equivalent.
 - 2. For push-on joint fittings and joints: Pipe restraints shall be "Field-Lok" gaskets by U.S. Pipe (or approved equivalent) or serrated restraint harness by EBAA Iron, Inc.
- C. Thrust blocks, gravity blocks, or mechanical pipe restraints may be used at Contractor's option, unless otherwise indicated on the Plans.
- D. Provide thrust blocks or mechanical pipe restraints at all fittings and changes in angle, alignment or elevation.
- E. Where depth or location of water piping, existing utilities, or other structures prohibit the use of standard thrust blocks, gravity blocks or mechanical pipe restraints may be used. Conform to NFPA 24 Standards.

2.14 TAPPING SLEEVES AND TAPPING VALVES

- A. Sleeves shall be epoxy coated and furnished with stainless steel washers, nuts and bolts. Mueller H-615 and H-619, Ford, or approved equivalent.
- B. Tapping valves shall have flanged inlet, Class 125, conforming to ASME B16.1 and furnished with stainless steel washers, nuts and bolts. Tapping valves shall be constructed with a mechanical joint outlet. Mueller T-687, T-642, T-681, or approved equivalent.

2.15 SERVICE SADDLES AND CORPORATION STOPS

- A. Service Saddles: Saddles shall conform to AWWA C800 and NSF 61.
 - 1. For DIP: Provide bronze or stainless steel body, double strap type with a 200 psi maximum working pressure. Mueller BR2 Series, Ford, or approved equivalent.
 - 2. For PVC: Provide bronze body, wide strap type. Mueller H-13000 Series, Ford, or approved equivalent.
 - 3. For PE: Provide stainless steel body, double strap style with a 250 psi maximum working pressure. Ford FSP-323, or approved equivalent.
- B. Corporation Stops: Provide ground key type; bronze conforming to ASTM B61 or ASTM B62, for a working pressure of 100 psi. and suitable for the working pressure of the system.
 - 1. Ends shall be suitable for adjoining pipe and connections, solder-joint, or flared tube compression type joint.
 - 2. Threaded ends shall conform to AWWA C800.
 - 3. Coupling nut for connection to flared copper tubing shall conform to ASME B16.26.
 - 4. Mueller H-15000 Series with "CC" threads and a copper flare straight connection outlet, Ford, or approved equivalent.

2.16 IDENTIFICATION MATERIALS AND DEVICES

- A. Marker Tape: Provide marker tape consisting of metallic foil bonded to plastic film not less than 2-inches wide. Film shall be inert polyethylene plastic. Film and foil shall each not be less than 1-mil. thick. The tape shall be identified with lettering, not less than 3/4-inch high, "CAUTION: WATER MAIN BELOW," repeated at approximately 24-inch intervals.
- B. Tracer Wire for Nonmetallic Piping: Provide 12 gage, coated copper or aluminum wire not less than 0.10 inch in diameter in sufficient length to be continuous over each separate run of nonmetallic pipe. Wire shall be tied in at all valves.
- C. Recycled Water identification signage is required according to City of Livermore standards.

2.17 SETTLEMENT JOINTS

- A. Flexible joints shall be used if a differential settlement of greater than 2-inches is anticipated. Flexible joints shall be ductile iron rated, rated for 350 psi working pressure and FM approved. Megalug Flextend or approved equivalent.
- B. Provide pipe restraint on either side of flexible joint to resist thrust forces.

2.18 CORROSION PROTECTION

- A. In soils with low resistivity, high sulfides, high/low ph, redox potential and/or poor surrounding drainage conditions, or as indicated in the Contract Documents, encase underground pipe and appurtenances in 4-mil, high-density cross-laminated (HDCL) polyethylene film or 8-mil linear low-density (LLD) polyethylene film in accordance with AWWA/ANSI C105/A21.5. U.S. Pipe, ACIPCO, or approved equivalent.

2.19 CATHODIC PROTECTION

- A. See Section 26 42 00 for cathodic protection requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where water service is being installed.
- B. Do not begin installation until unsatisfactory conditions have been corrected.

3.2 LOCATION OF WATER LINES

- A. Where the location of the water line is not clearly defined by dimensions on the Plans, do not lay water line closer than 10 feet horizontally from any sewer line.
- B. Where water lines cross under gravity sewer lines, encase sewer line in concrete for a distance of at least 10 feet on each side of the crossing, unless sewer line is made of pressure pipe with rubber-gasketed joints and no joint is located within 3 feet horizontally of the crossing.
- C. Where water lines cross sewer force mains and inverted siphons, install water line at least 2 feet above these sewer lines.
- D. When joints in the sewer line are closer than 3 feet horizontally from the water line, encase sewer line joints in concrete.

- E. Do not lay water lines in the same trench with other utilities.
- F. Install water lines at 3'-0" minimum depth or as detailed on Plans.

3.3 INSTALLATION OF PIPING

- A. Inspection:
 - 1. Before placing in position, inspect pipe for noticeable defects. Clean the pipe, fittings, valves, and accessories, and maintain in a clean condition.
 - 2. Remove fins and burrs from pipe and fittings.
- B. Pipe laying and jointing:
 - 1. Provide proper facilities for lowering sections of pipe into trenches.
 - 2. Do not drop or dump pipe, fittings, valves, or any other water line material into trenches.
 - 3. Cut pipe accurately to length established at the site and work into place without springing or forcing. Replace any pipe or fitting that does not allow sufficient space for proper installation of jointing material.
 - 4. Blocking or wedging between bells and spigots will not be permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of lying.
 - 5. Grade the pipeline in straight lines; avoid the formation of dips and low points.
 - 6. Support pipe at proper elevation and grade.
 - 7. Provide secure firm, uniform support. Wood support blocking will not be permitted.
 - 8. Lay pipe so that the full length of each section of pipe and each fitting rests solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings.
 - 9. Provide anchors and supports where indicated and where necessary for fastening work into place.
 - 10. Make proper provision for expansion and contraction of pipelines.
 - 11. Keep trenches free of water until joints have been properly made.
 - 12. Do not lay pipe when conditions of trench or weather prevent proper installation.
 - 13. All fittings shall be blocked with appropriately sized thrust blocks as shown in the Contract Documents.
- C. Installation of Tracer Wire:
 - 1. Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe.
 - 2. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.
- D. Connections to Existing Lines:
 - 1. Make connections to existing water lines after approval is obtained and with a minimum interruption of service on the existing line.
 - 2. Make connections to existing lines under pressure in accordance with the recommended procedures of a manufacturer of pipe of which the line being tapped is made.
 - 3. The end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads to keep out debris and contamination.

3.4 INSTALLATION OF DUCTILE-IRON PIPING

- A. Install pipe and fittings in accordance with requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.
- B. Jointing:
 - 1. Provide push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.
 - 2. Provide mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and with the recommendations of AWWA C111.
 - 3. Provide flanged joints with the gaskets, bolts, and nuts specified for this type joint.
 - a. Install flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other equipment and accessories.
 - b. Align bolt holes for each flanged joint.

- c. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted.
 - d. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without over straining the flange.
 - e. Where flanged pipe and fitting have dimensions that do not allow the installation of a proper flanged joint as specified, replace it by one of proper dimensions.
 - f. Use set screwed flanges to make flanged joints where conditions prevent the use of full-length flanged pipe. Assemble in accordance with the recommendations of the set screwed flange manufacturer.
4. Provide insulating joints with the gaskets, sleeves, washers, bolts, and nuts previously specified for this type joint. Assemble insulating joints as specified for flanged joints. Bolts for insulating sleeves shall be full size for the bolt holes.
 5. Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.
- C. Exterior Protection: Completely encase buried ductile iron pipelines and underground appurtenances with polyethylene wrap. Install 8-mil linear low-density polyethylene (LLD) film or 4-mil high-density cross-laminated (HDCL) film per manufacturer's recommendations and in accordance with AWWA/ANSI C105/A21.5 and ASTM A674.
- D. Pipe Anchorage:
1. Provide concrete thrust blocks or restrained joints for pipe anchorage, except where metal harness is indicated on the Construction Documents.
 2. Pipe anchorage shall be in accordance with NFPA 24 Standards.

3.5 INSTALLATION OF POLYVINYL CHLORIDE PIPING

- A. Install pipe and fittings in accordance with the requirements of UNI B-3 for the following:
1. The laying of pipe, joining PVC pipe to fittings and accessories.
 2. The setting of hydrants, valves, and fittings.
- B. Comply with the recommendations for pipe joint assembly and appurtenance installation in AWWA Manual M23, Chapter 7, "Installation."
- C. Comply with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111.
- D. Jointing:
1. Provide push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings.
 2. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel.
 3. For push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint.
 4. Use an approved lubricant recommended by the pipe manufacturer for push-on joints.
 5. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of UNI B-3 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly.
 6. Make compression-type joints/mechanical-joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint. Cut off spigot end of pipe for compression-type joint or mechanical-joint connections and do not re-bevel.
 7. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.
- E. Pipe Anchorage:
1. Provide concrete thrust blocks or restrained joints for pipe anchorage, except where metal harness is indicated on the Construction Documents.

2. Anchorage shall be in accordance with the requirements of UNI B-3 and in accordance with NFPA 24 Standards for reaction or thrust blocking and plugging of dead ends, except that size and positioning of thrust blocks shall be as indicated on the Construction Documents.

3.6 INSTALLATION OF POLYETHYLENE PIPING

- A. Install pipe, fittings, and appurtenances in accordance with PPI and Manufacturer's Recommendations.
- B. Jointing:
 1. Provide mechanical joints, compression fittings, or flanges as recommended by the manufacturer.
 2. Jointing shall be performed using proper equipment and machinery by trained and certified personnel.
 3. Joints, fittings and tools shall be clean and free of burrs, oil, and dirt.
 4. Butt fusion:
 - a. Pipe ends shall be faced to establish clean, parallel mating surfaces.
 - b. Align and securely fasten the components to be joined squarely between the jaws of the joining machine.
 - c. Heat the ends of the pipe to the pipe manufacturer's recommended temperature interface pressure and time duration. A pyrometer or other surface temperature measuring device should be used to insure proper temperature of the heating tool. Temperature indicating crayons shall not be used on a surface which will come into contact with the pipe or fitting.
 - d. Prevent molten plastic from sticking to the heater faces. Molten plastic on the heater faces shall be removed immediately according to the tool manufacturer's instructions.
 - e. Bring the molten ends together with sufficient pressure to properly mix the pipe materials and form a homogeneous joint. Hold the molten joint under pressure until cooled adequately to develop strength. Refer to the Manufacturer's recommendations for temperature, pressure, holding, and cooling times.
 - f. Remove the inside bead from the fusion process using Manufacturer's recommended procedure.
 5. Socket fusion:
 - a. Mixing manufacturers' heating tools and depth gages will not be allowed unless the tools conform to ASTM F1056.
 - b. Pipe ends shall be faced square to establish clean, parallel mating surfaces.
 - c. Clamp the cold ring on the pipe at the proper position using a depth gauge.
 - d. Heat the tool to the pipe manufacturer's recommended temperature. A pyrometer or other surface temperature measuring device should be used to insure proper temperature. Temperature indicating crayons shall not be used on a surface which will come into contact with the pipe or fitting.
 - e. Follow manufacturer's recommendations for bringing the hot tool faces into contact with the outside surface of the end of the pipe and the inside surface of the socket fitting.
 - f. Simultaneously remove the pipe and fitting from the tool.
 - g. Inspect the melt pattern for uniformity and immediately insert the pipe squarely and fully into the socket of the fitting until the fitting contacts the cold ring. Do not twist the pipe or fitting during or after the insertion.
 - h. Hold or block the pipe in place during cooling.
 6. Electrofusion:
 - a. Unless the operation is for a saddle-type electrofusion joint, pipe ends shall be faced square to establish clean, parallel mating surfaces.
 - b. Clamp the pipe and fitting at the proper position in the fixture.
 - c. Connect the electrofusion control box to the fitting and to the power source. Apply the electric current using manufacturer's instructions.
 - d. Allow the joint to cool before removing the clamping fixtures.

3.7 INSTALLATION OF VALVES

- A. Install gate valves conforming to AWWA C500 and UL 262 in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix (Installation, operation, and Maintenance of Gate Valves) to AWWA C509.

- B. Install gate valves conforming to AWWA C509 in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix (Installation, Operation, and Maintenance of Gate Valves) to AWWA C509.
- C. Install gate valves on PVC water mains in addition in accordance with the recommendations for appurtenance installation in AWWA Manual M23, Chapter 7, "Installation."
- D. Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation, except as otherwise indicated.
- E. Provide and assemble joints to gate valves and check valves as specified for making and assembling the same type joints between pipe and fittings.

3.8 INSTALLATION OF VALVE AND METER BOXES

- A. Boxes shall be centered over the appurtenance so as not to transmit shock or stress. Covers shall be set flush with the surface of the finished pavement, or as shown in the Construction Documents. Backfill shall be placed around the boxes and compacted to the specified level in a manner that will not damage or displace the box from proper alignment or grade. Misaligned boxes shall be excavated, plumbed, and backfilled at no additional cost to the District.

3.9 INSTALLATION OF HYDRANTS

- A. Install hydrants, except for metal harness, plumbed vertical, in accordance with AWWA C600 for hydrant installation and as indicated.
- B. Provide and assemble joints as specified for making and assembling the same type joints between pipe and fittings. Hydrants shall be set so that mounting bolts clear the top of finished grade by three inches so bolts may be easily replace if needed.
- C. Provide metal harness as specified under pipe anchorage requirements for the respective pipeline material to which hydrant is attached.

3.10 SERVICE LINE CONNECTIONS TO WATER MAINS

- A. Connect service lines of size shown on plans to the main with a rigid connection or a corporation stop and gooseneck. Install a gate valve on the service line.
- B. Connect service lines to ductile-iron water mains in accordance with AWWA C600 for service taps.
- C. Connect service lines to PVC plastic water mains in accordance with UNI-B-8 and the recommendations of AWWA Manual M231, Chapter 9, "Service Connections."

3.11 INSTALLATION OF BACKFLOW PREVENTERS

- A. Devices shall be installed horizontal and level, with three feet minimum clearances from obstructions.
- B. Bottom of backflow device shall be 12-24" above grade.

3.12 WATER TANKS

- A. Install water tanks per Manufacturer's recommendations in conformance with AWWA D103.

3.13 HYDROSTATIC PIPELINE TESTING

- A. Requirements:
 - 1. After the pipe has been laid and backfilled, perform hydrostatic pressure tests.

2. Do not conduct tests until at least 12 hours have elapsed since pipe lying and at least 5 days have elapsed since placing of concrete thrust blocks.
3. Fill the pipe with water which shall remain without external application of pressure for 24 hours before tests are conducted.
4. Prior to hydrostatic testing, flush pipe system with fresh water until piping is free of dirt and foreign matter.
5. Apply pressure by a pump and measured by a test gage. All necessary apparatus and labor for conducting the pressure and leakage tests shall be furnished by the Contractor.
6. Ensure the release of air from the line during filling, and prevent collapse due to vacuum when dewatering the line.
7. For pressure test, use a hydrostatic pressure not less than 200 psi for fire water or combined water systems and 1 ½ times operating pressure for domestic water systems. The duration of the test shall not be less than 4 hours with the variation in pressure of not more than 5 psi for the duration of the test.

B. Leakage Tests:

1. At Contractor's option, leakage tests can be performed at the same time as hydrostatic pressure tests.
2. Leakage rate shall be measured for at least 4 hours with a certified water meter, or other approved method. If requested, meter certification shall be submitted to the District for approval prior to testing.
3. Leakage shall not be measured by a drop in pressure in a test section over a period of time.
4. Leakage at mechanical couplings and joints, tapping sleeves, saddles, flanged joints, and copper piping will not be accepted. Correct any visible leaks.
5. Push-on joints: Test ductile iron pipe for leakage in accordance with AWWA C600 as shown in the following table:

TABLE 1
 Allowable Leakage per 1000 feet of DIP Pipeline (Gal/Hr)

Average Test Pressure (psi)	Nominal Pipe Diameter - Inches									
	3	4	6	8	10	12	14	16	18	20
300	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60
275	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49
250	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37
225	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25
200	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12

6. When the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.
7. Test polyvinyl chloride pipe for leakage in accordance with the recommendations of the Uni-Bell Plastic Pipe Association (UNI) as shown in the following table

TABLE 2
 Allowable Leakage per 1000 feet or 50 joints of PVC Pipeline (Gal/Hr)

Nominal Pipe Size (inches)	Average Test Pressure in Line (psi.)	
	200	250
4	0.38	0.43
6	0.57	0.64
8	0.76	0.85
10	0.96	1.07
12	1.15	1.28
14	1.34	1.50
16	1.53	1.71
18	1.72	1.92
20	1.91	2.14

8. Should any section of new pipe fail to pass either test, locate and repair the defective pipe and repeat the test.

3.14 STERILIZATION AND FLUSHING

A. General:

1. Domestic water lines, mains, and branches by chlorination in accordance with AWWA C601 and as herein specified.

B. Sterilization Methods:

1. Liquid Chlorine Solution Method:

- a. Flush all foreign matter from mains, branch runs, hydrant runs, and installed services.
- b. Introduce liquid chlorine solution at appropriate locations to assure uniform distribution through the facilities at the proper concentration.
- c. Do not use installed copper service lines to convey the concentrated chlorine solution to the mains.
- d. The sanitizing solution shall be retained in the facilities for a period of 24 hours after which each service, hydrant run, branch run and dead end shall be flushed until:
 - 1) Residual chlorine is less than 1 part per million.
 - 2) Residual chlorine is no greater than the concentration of chlorine in the water supplied for flushing.
- e. Chlorine shall be a 1 percent solution (containing 10,000 parts per million available chlorine) or shall be obtained by use of dry chlorine in tablet form firmly attached to inside tope of the pipe.
- f. The required concentration of chlorine in the pipe is 50 parts per million. This concentration may be attained by adding 5 gallons of the chlorine solution to 1,000 gallons of water.
- g. The weight of chlorine or chlorine compound required to make a 1 percent chlorine solution is as follows:

TABLE 3
 One-Percent Chlorine Solution Mix

AMOUNT OF PRODUCT COMPOUND		QUANTITY OF WATER (in gallons)
High-Test Calcium Hypochlorite	1 pound	7.50

AMOUNT OF PRODUCT COMPOUND		QUANTITY OF WATER (in gallons)
(65-70% Cl)		
Chlorinated Lime (32-35% Cl)	2 pounds	7.50
Liquid Laundry Bleach (5.25% Cl)	1 gallon	4.25
Liquid Chlorine (100% available chlorine)	0.62 pounds	7.50

2. HTH Tablet Method:
- a. The required concentration of chlorine in the mains may be obtained by the use of HTH tablets as produced by Olin Mathieson in the following quantities or approved equivalent:
 TABLE 4
 HTH Tablet (70%) Dosage
 Number of Tablets Per Length of Pipe

Length of Section	DIAMETER OF PIPE				
	4 inches	6 inches	8 inches	10 inches	12 inches
13 feet	1	2	3	4	6
18 feet	1	2	3	5	6
20 feet	1	2	3	5	7
30 feet	2	3	5	7	10
36 feet	2	3	5	8	12
40 feet	2	4	6	9	14
100 feet	4	9	15	23	30

- b. Tablets are to be fastened to the inside top surface of each length of pipe using "Permatex No. 1" no earlier than the day pipe is laid.
- c. Tablets shall not be installed in the pipe and left overnight before laying and shall not be accessible at any time for casual pilferage by the general public or by children. Tablets shall be stored in a hermetically sealed container.
- d. The new water lines are to be slowly filled with water. Air is to be exhausted from each dead end, branch run, hydrant run, and installed service.
- e. Water shall be retained for a period of 24 hours, after which each service, hydrant run, branch run and dead end shall be thoroughly flushed to clear foreign matter and until:
 - 1) Residual chlorine concentration is less than 1 part per million
 - 2) Residual chlorine is no greater than the concentration of chlorine in the water supplied for flushing.

- C. Bacteriological Testing:
1. Samples shall be gathered and tests conducted at the expense of the Contractor by a laboratory certified by the California Department of Health Services as an Environmental Testing Laboratory (ELAP).
 2. Samples are to be taken at representative points as required by the District and authorities having jurisdiction.

3. The new water lines shall remain isolated and out of service until satisfactory test results have been obtained that:
 - a. Meet the requirements of the California Department of Health Services, Drinking Water Standards.
 - b. District has accepted the results as indicative of the bacteriological condition of the facilities.
 - c. If unsatisfactory or doubtful results are obtained from the initial sampling, repeat the chlorination process until acceptable test results are reported.

3.15 HYDRANT FLOW TESTING

- A. After completion of the pipe and hydrant installation and service connections, the new hydrants shall be flow tested and results provided to the District's Representative and Engineer. The Contract shall provide the following information:
 1. Who performed the test.
 2. Testing date.
 3. Hydrant location.
 4. Static pressure (psig).
 5. Residual pressure (psig).
 6. Flow (gpm).
 7. Orifice size (in.)]

END OF SECTION

SECTION 333000 – SANITARY SEWER

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes general requirements, products, and methods of execution relating to on-site sanitary sewerage excluding portions within five feet of buildings unless otherwise noted. Any work within the public right-of-way shall be constructed to the standards of the City of Livermore.
 - 1. Sanitary Sewer System, including piping and structures.
- B. Contractor shall provide all labor, equipment, and materials, unless otherwise noted.
- C. Related Sections:
 - 1. Section 31 23 33 – TRENCHING, BACKFILLING, AND COMPACTING.
 - 2. Section 03 30 00 – CAST-IN-PLACE CONCRETE.

1.2 SUBMITTALS

- A. Comply with the requirements of Section 01 33 00 – SUBMITTAL PROCEDURES.
- B. Product Data: Manufacturer's literature and data, including, where applicable, pressure rating, capacity, labels, or other markings on equipment made to the specified standards for materials, for the following:
 - 1. Piping and fittings.
 - 2. Jointing material.
 - 3. Gaskets, couplings, and sleeves.
 - 4. Precast concrete structures, including manholes.
 - 5. Concrete mix design for sanitary structures.
 - 6. Manhole lids and frames.
 - 7. Steps.
 - 8. Clean-out boxes.
 - 9. Backwater valves.
 - 10. Grease interceptor
 - 11. Vent piping and screen

1.3 QUALITY ASSURANCE

- A. Comply with the latest editions of the following Standards and Regulations:
 - 1. American Concrete Pipe Association (ACPA).
 - a. ACPA 01-102 Concrete Pipe Handbook.
 - b. ACPA 01-103 Concrete Pipe Installation Manual.
 - 2. American National Standards Institute (ANSI).
 - a. ANSI B18.5.2.1M Metric Round Head Short Square Neck Bolts.
 - 3. American Railway Engineering & Maintenance-of-Way Association (AREMA).
 - a. AREMA 1-5 Pipelines.
 - 4. American Society for Testing and Materials (ASTM).
 - a. A 123/A 123M Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A 307 Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - c. A 47 Ferritic Malleable Iron Castings. **
 - d. A 47M Ferritic Malleable Iron Castings (Metric). **
 - e. A 48 Gray Iron Castings. **
 - f. A 48M Gray Iron Castings (Metric). **
 - g. A 536 Ductile Iron Castings.
 - h. A 563 Carbon and Alloy Steel Nuts.
 - i. A 563M Carbon and Alloy Steel Nuts (Metric).
 - j. A 74 Cast Iron Soil Pipe and Fittings.

- k. A 746 Ductile Iron Gravity Sewer Pipe.
- l. C 12 Installing Vitrified Clay Pipe Lines.
- m. C 14 Concrete Sewer, Storm Drain, and Culvert Pipe.
- n. C 14M Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).
- o. C 150 Portland Cement.
- p. C 260 Air-Entraining Admixtures for Concrete.
- q. C 270 Mortar for Unit Masonry.
- r. C 301 Vitrified Clay Pipe.
- s. C 33 Concrete Aggregates.
- t. C 361 Reinforced Concrete Low-Head Pressure Pipe.
- u. C 361M Reinforced Concrete Low-Head Pressure (Metric).
- v. C 425 Compression Joints for Vitrified Clay Pipe and Fittings.
- w. C 443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- x. C 443M Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric).
- y. C 478 Precast Reinforced Concrete Manhole Sections.
- z. C 478M Precast Reinforced Concrete Manhole Sections (Metric).
- aa. C 494 Chemical Admixtures for Concrete.
- bb. C 564 Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- cc. C 700 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- dd. C 76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- ee. C 76M Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric).
- ff. C 828 Low-Pressure Air Test of Vitrified Clay Pipe Lines.
- gg. C 920 Elastomeric Joint Sealants.
- hh. C 923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
- ii. C 923M Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric).
- jj. C 924 Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
- kk. C 924M Testing Concrete Pipe Sewer Liner by Low-Pressure Air Test Method (Metric).
- ll. C 94 Ready-Mixed Concrete. **
- mm. C 94/C 94M Ready-Mixed Concrete.
- nn. C 969 Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
- oo. C 969M Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric).
- pp. C 972 Compression-Recovery of Tape Sealant.
- qq. C 990 Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealers.
- rr. C 990M Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric).
- ss. D 1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- tt. D 1785 Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120.
- uu. D 2235 Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- vv. D 2241 Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- ww. D 2321 Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- xx. D 2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- yy. D 2464 Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- zz. D 2466 Poly(Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 40.
- aaa. D 2467 Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- bbb. D 2680 Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
- ccc. D 2751 Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- ddd. D 2996 Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- eee. D 2997 Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- fff. D 3034 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

- ggg.D 3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- hhh.D 3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- iii. D 3262 "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
- jjj. D 3350 Polyethylene Plastics Pipe and Fittings Materials.
- kkk. D 3753 Glass-Fiber-Reinforced Manholes.
- lll. D 3840 "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Non-pressure Applications.
- mmm. D 4101 Propylene Injection and Extrusion Materials.
- nnn.D 412 Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension.
- ooo.D 4161 "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
- ppp.D 624 Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
- qqq.F 1336 Poly(Vinyl Chloride) (PVC) Gasketed Sewer Fittings.
- rrr. F 402 Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
- sss. F 405 Corrugated Polyethylene (PE) Tubing and Fittings.
- ttt. F 477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- uuu.F 714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- vvv. F 758 Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.
- www. F 794 Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- xxx. F 894 Polyethylene (PE) Large Diameter
- yyy. Profile Wall Sewer and Drain Pipe.
- zzz. F 949 Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.
- 5. ASME International (ASME).
 - a. B1.20.1 Pipe Threads, General Purpose, Inch.
 - b. B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
 - c. B18.2.2 Square and Hex Nuts.
 - d. B18.5.2.2M Metric Round Head Square Neck Bolts.
- 6. American Water Works Association (AWWA).
 - a. C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - b. C105 Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - c. C110 Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm through 1219 mm), for Water.
 - d. C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - e. C115 Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
 - f. C151 Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - g. C153 Ductile-Iron Compact Fittings for Water Service.
 - h. C302 Reinforced Concrete Pressure Pipe, Noncylinder Type.
 - i. C600 Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - j. C606 Grooved and Shouldered Joints.
 - k. C900 Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution.
 - l. M23 Manual: PVC Pipe - Design and Installation.
 - m. M9 Manual: Concrete Pressure Pipe.
- 7. California Department of Transportation (Caltrans): Standard Specifications:
 - a. Section 55: Steel Structures
 - b. Section 70: Miscellaneous Drainage Facilities
 - c. Section 75: Miscellaneous Metal
- 8. Cast Iron Soil Pipe Institute (CISPI).
 - a. 301 Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 - b. 310 Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- 9. Uni-Bell PVC Pipe Association (UBPPA).
 - a. UNI-B-3 Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe (Nominal Diameters 4-36 Inch).
 - b. UNI-B-6 Recommended Practice for the Low-Pressure Air Testing of Installed Sewer Pipe.

10. City of Livermore Standard Plans and Specifications.
11. City of Livermore Water Resources Division Standard Plans and Specifications.
12. American Association of State Highway and Transportation Officials (AASHTO) for H20 Loading.
13. American Concrete Institute (ACI).
14. Other authorities having jurisdiction.

- B. System Description: Grades and elevations are to be established with reference to the benchmarks referenced on the Drawings.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage
1. Piping: Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.
 2. Metal Items: Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.
- B. Handling
1. Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. When handling lined pipe, take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.

PART 2 - PRODUCTS

2.1 PIPING

- A. Polyvinyl Chloride (PVC) Pipe: PVC pipe and fittings conforming to ASTM D3034, SDR 26 with bell-and-spigot type of rubber gasket joints. Bells shall be integral with pipe. Spigot end pipe with separate double hub couplings is not acceptable.
- B. Vitrified Clay Pipe (VCP): VCP and fitting shall conform to ASTM C700, Extra Strength.
- C. Polyethylene Pipe (PE): PE 4710, Pressure Class, DR 11, conforming to AWWA C906. Driscopex 4000/4100, or approved equivalent.
1. Fittings shall conform to AWWA C901 or AWWA C906. Driscopex, or approved equivalent.
 - a. Socket type fittings shall conform to ASTM D2683.
 - b. Butt fusion fittings shall conform to ASTM D3261.
 - c. Electrofusion fittings shall comply with ASTM F1055.

2.2 MANHOLES

- A. Manholes shall be pre-cast concrete of the size and shape shown on the Drawings and shall conform to Sections 70-4.02 of the Caltrans Standard Specifications and to ASTM C478. Equivalent poured-in-place structures may be used at the Contractor's option. Concrete shall consist of Type II cement
- B. Frames and covers shall be cast iron conforming to Section 55-2.03 and 75-1.02 of the Caltrans Standard Specifications. Manhole covers shall have the words "SANITARY SEWER" in letters not less than 2 inches cast into the cover. The clear opening for all manhole covers shall be 24 inches.
- C. All interior concrete surfaces shall be coated with Xypex Concentrate or approved equivalent. Use of a water-resistant admix such as "Xypex Crystalline" is acceptable, at contractor option.

- D. Frames and lids for manholes shall be match-marked in pairs before delivery to the job site. The lids shall fit into their frames without rocking.
- E. Reinforcing Bars: Reinforcing bars shall be of intermediate grade billet steel conforming to ASTM A615 and shall be of the size shown on the Standard Details or in the Drawings. Bars shall be of the round deformed type, free from injurious seams, flaws, or cracks, and shall be cleaned of all rust, dirt, grease and loose scales.
- F. Portland Cement Concrete: Concrete for manhole bases, inlets, and other concrete structures shall be conforming to the requirements of Caltrans Section 90 and as herein specified. The concrete shall be Class 2. The grading of the combined aggregate shall conform with the Caltrans requirements of the 1/2-inch maximum. The consistency of the fresh aggregate shall be such that the slump does not exceed four inches, as determined by Test Method No. Calif. 520. The concrete shall have a minimum design compressive strength of 3,000 psi after 28 days.

2.3 PIPE TO STRUCTURE CONNECTOR/SEAL

- A. flexible pipe to manhole connector shall be used for all pipe penetrations and/or cast-in-place concrete structures.
 - 1. The seal shall provide a flexible, positive, watertight connection between pipe and concrete wastewater structures. The connector shall assure that a seal is made between (1) the connector and the structure wall, and (2) between the connector and the pipe. The seal between the connector and the manhole wall shall be made by casting the connector integrally with the structure wall during the manufacturing process in such a manner that it will not pull out during coupling. The seal between connector and pipe will be made by way of a stainless steel take down band compressing the gasket against the outside diameter of the pipe.
 - 2. The connector shall be molded from materials whose physical/chemical properties meet or exceed the physical/chemical resistant properties outlined in ASTM C-923. The connector and stainless steel hardware shall meet or exceed the performance requirements proscribed in ASTM C-923.
 - 3. The connector shall be of size specifically designed for the pipe material being used and shall be installed in accordance with recommendations of the manufacturer.
 - 4. Connectors shall be Z-LOK or G3 connectors manufactured by A-LOK Products Inc. or approved equivalent.

2.4 CLEAN-OUTS

- A. A box shall be provided for each clean-out. Boxes shall be pre-cast concrete with cast iron frame and cover marked "SAN SEWER"; Christy G05 or approved equivalent.

2.5 BACKWATER VALVES

- A. Backwater valves shall be Josam Series 67500, or approved equivalent.

2.6 SETTLEMENT JOINTS

- A. Flexible joints shall be used if a differential settlement of greater than 2-inches is anticipated. Flexible joints shall be ductile iron rated, rated for 350 psi working pressure and FM approved. Megalug Flextend or approved equivalent.
- B. In forced mains, provide pipe restraint on either side of flexible joint to resist thrust forces.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. Pipe shall be installed in conformance with Section 31 23 33 – TRENCHING, BACKFILLING, AND COMPACTING, and manufacturer's recommendations.

- B. Pipe laying:
 - 1. No pipe shall be laid until the Geotechnical Engineer inspects and approves the conditions of the bottom of the trench.
 - 2. Pipe laying shall proceed "up grade" with the spigot section of the bell-and-spigot pipe pointing in the direction of the flow.
 - 3. Each section of pipe shall be laid true to line and grade and in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets in the flow line.
 - 4. Pipe shall not be laid when the condition of the trench or the weather is unsuitable.
- C. Debris Control:
 - 1. The interior of the sewer pipe shall be kept clean of dirt and debris at all times. When work is not in progress, open ends of pipe and fittings shall be plugged.
 - 2. Where clearing after laying is difficult because of small pipe size, a suitable swab or squeegee shall be kept in the pipe and pulled forward past every joint immediately after joining has been completed.

3.2 POURED-IN-PLACE CONCRETE

- A. Concrete shall be mixed in accordance with applicable provisions of Section 90 of the Caltrans Standard Specifications.
- B. Construction of concrete structures shall conform to applicable provisions of Section 51 of the Caltrans Standard Specifications. Unless otherwise noted herein or in the Drawings, exposed surfaces of structures shall be Class 1 surface finish.
- C. Curing shall conform to applicable portions in Section 90 of Caltrans Standard Specifications. No pigment shall be used in curing compounds. All work shall be subject to inspection. No concrete shall be placed until the District Representative has approved the forms and reinforcement.
- D. Concrete shall not be dropped freely where reinforcing bars will cause segregation, nor shall it be dropped freely more than six feet. Spouts, elephant trunks, or other approved means shall be used to prevent segregation.

3.3 PIPELINE AIR TESTING AND FLUSHING

- A. All new sections of sanitary sewer shall be tested using the following procedures:
 - 1. Test is conducted between two consecutive manholes, or as directed by the District's Representative.
 - 2. The test section of the sewer shall be plugged at each end. One of the plugs used at the manhole shall be tapped and equipped for the air inlet connection for filling the line from an air compressor.
 - 3. All service laterals, stubs, and fittings into the sewer test section shall be properly capped or plugged and carefully braced against the internal pressure to prevent air leakage by slippage and blowout.
 - 4. Connect air hose to tapped plug selected for the air inlet. Connect the other end of the air hose to the portable air control equipment, which consists of valves and pressure gauges used to control the air entry rate into the sewer test section, and to monitor the air pressure in the pipeline. More specifically, the air control equipment includes a shut-off valve, pressure regulating valve, pressure reduction valve, and a monitoring pressure gauge having a pressure range from 0-5 psi. The gauge shall have minimum divisions of 0.10 psi and an accuracy of 0.40 psi.
 - 5. Connect another air hose between the air compressor (or other source of compressed air) and the air control equipment. This completes the test equipment set-up. Test operations may commence.
 - 6. Supply air to the test section slowly, filling the pipeline until a constant pressure of 3.5 psig is maintained. The air pressure must be regulated to prevent the pressure inside the pipe from exceeding 5.0 psig.
 - 7. When constant pressure of 3.5 psig is reached, throttle the air supply to maintain the internal pressure above 3.0 psig for at least 5 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall. During this stabilization period, it

is advisable to check all capped and plugged fittings with a soap solution to detect any leakage at these connections. If leakage is detected at any cap plug, release the pressure in the line and tighten all leaky caps and plugs. Start the test operation again by supplying air. When it is necessary to bleed off the air to tighten or repair a faulty plug, a new 5-minute interval must be allowed after the pipeline has been refilled.

8. After the stabilization period, adjust the air pressure to 3.5 psig and shut-off or disconnect the air supply. Observe the gauge until the air pressure reached 3.0 psig. At 3.0 psig, commence timing with a stopwatch until the pressure drops to 2.5 psig, at which time the stop watch is stopped. The time required, as shown on the stopwatch, for a pressure loss of 0.5 psig is used to compute the air loss.
9. If the time, in minutes and seconds, for the air pressure drop from 3.0 to 2.5 psi is greater than that shown in the following table for the designated pipe size, the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued at any time.
10. If the time, in minutes and seconds, for the 0.5 psig drop is less than that shown in the following table for the designated pipe size, the section of the pipe shall not have passed the test; therefore, adequate repairs must be made and the line retested.

Requirements for Air Testing

Pipe in Size (inches)	Minutes	Time (seconds)
4	2	32
6	3	50
8	5	6
10	6	22
12	7	39
14	8	56
15	9	35
16	10	12
18	11	34
20	12	30

(For larger diameter pipe use the following: Minimum time in seconds = 462 x pipe diameter in feet)

11. For 8 inch and smaller pipe, only: if, during the 5 minute saturation period, pressure drops less than 0.5 psig after the initial pressurization and air is not added, the pipe section undergoing test shall have passed.
12. Multi-pipe sizes: when the sewer line undergoing test is 8 inch or larger diameter pipe and includes 4 inch or 6 inch laterals, the figures in the table for uniform sewer main sizes will not give reliable or accurate criteria for the test. Where multi-pipe sizes are to undergo the air test, the State's representative can compute the "average" size in inches which is then multiplied by 38.2 seconds. The results will give the minimum time in seconds acceptable for a pressure drop of 0.5 psig for the "averaged" diameter pipe.
13. Adjustment Required for Groundwater:
 - a. An air pressure correction is required when the ground water table is above the sewer line being tested. Under this condition, the air test pressure must be increased .433 psi for each foot the ground water level is above the invert of the pipe.
 - b. Where ground water is encountered or is anticipated to be above the sewer pipe before the air testing will be conducted, the following procedure shall be implemented at the time the sewer main and manholes are constructed.
 - 1) Install a ½ inch diameter pipe nipple (threaded one or both ends, approximately 10 inch long) through the manhole wall directly on top of one of the sewer pipes entering the manhole with threaded end of nipple extending inside the manhole.
 - 2) Seal pipe nipple with a threaded 1/2 inch cap.
 - 3) Immediately before air testing, determine the ground water level by removing the threaded cap from the nipple, blowing air through the pipe nipple to remove any obstruction, and then connecting a clear plastic tube to the pipe nipple.
 - 4) Hold plastic tube vertically permitting water to rise in it to the groundwater level.

- 5) After water level has stabilized in plastic tube, measure vertical height of water, in feet, above invert of sewer pipe.
- 6) Determine air pressure correction, which must be added to the 3.0 psig normal starting pressure of test, by dividing the vertical height in feet by 2.31. The result gives the air pressure correction in pounds per square inch to be added.
Example: if the vertical height of water from the sewer invert to the top of the water column measures 11.55 feet, the additional air pressure required would be:
 $(11.55)/(2.31) = 5.0$ psig
Therefore, the starting pressure of the test would be 3.0 plus 5 or 8.0 psig, and the ½ pound drop becomes 7.5 psig. There is no change in the allowable drop (0.5 psig) or in the time requirements established for the basic air test.

3.4 DEFLECTION TESTING & CLEANING

- A. Flush system pipelines, manholes and related structures with water to clean. A metal screen shall be used downstream at the point of connection to the existing system to collect and remove any rock or other debris that is flushed out during cleaning. Reclaimed water shall be used where available.
- B. Upon completion of work, perform a deflection test on entire length of installed plastic pipeline. Completed work includes superimposed loads adjacent to and over the pipeline, such as compacted backfill and earthwork, and does not include paving, concrete curbs and gutters, sidewalks, walkways, and landscaping.
- C. Under external loads, deflection of pipe in the installed pipeline shall not exceed 4.5 percent of the average inside diameter of pipe.
- D. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection-measuring device.
- E. Pull-Through Device:
 1. Provide a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft.
 - a. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section.
 - b. Pull-through device may also be of a design approved by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device.
 2. Ball, cylinder, or circular sections shall conform to the following:
 - a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
 - b. A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.
 - c. Center bored and through bolted with a ¼ inch minimum diameter steel shaft having yield strength of not less than 70,000 pounds per square inch, with eyes or loops at each end for attaching pulling cables.
 - d. Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.
 3. Pull-Through Device:
 - a. Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water.
 - b. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.
- F. Deflection measuring Device:
 1. Sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension.
 2. Obtain approval of deflection measuring device prior to use.
- G. Deflection Measuring Device Procedure:

1. Measure deflections through each run of installed pipe.
 2. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction.
 3. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflections, replace with new pipe, and completely retest in same manner and under same conditions.
- H. Warranty Period Test: Pipe found to have a deflection of greater than 5 percent of average inside diameter when deflection test is performed just prior to end of 1 year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection.

3.5 VIDEO INSPECTION

- A. After completion of the pipe installation, service connections, flushing and cleaning, and prior to placement of pavement, the sewer line shall be video inspected with a color closed-circuit television with tilt-head camera recorded in DVD format. Two (2) copies of the inspection DVD and log sheets shall be provided to the [District's/Owner's Representative].
1. The following observations from video inspections will be considered defects in the construction of sewer pipelines and will require correction prior to placement of pavement:
 - a. Low spot (1/2 inch or greater - mainlines only).
 - b. Joint separations (1/4 inch or greater opening between pipe sections).
 - c. Cocked joints present in straight runs or on the wrong side of pipe curves.
 - d. Chips in pipe ends.
 - e. Cracked or damaged pipe.
 - f. Dropped joints.
 - g. Infiltration.
 - h. Debris or other foreign objects.
 - i. Other obvious deficiencies.
 - j. Irregular condition without logical explanation.

END OF SECTION

SECTION 334000 - STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes general requirements, products, and methods of execution relating to on-site storm drainage excluding portions within five feet of buildings unless otherwise noted. Any work within the public right-of-way shall be constructed to the standards of the City of Livermore County of Alameda; State of California Department of Transportation; as may be appropriate.
 - 1. Storm drain piping.
 - 2. Storm drain structures including curb inlets, catch basins, area drains, and manholes.
- B. Contractor shall provide all labor, equipment, and materials, unless otherwise noted.
- C. Related Sections:
 - 1. Section 31 23 33 – TRENCHING, BACKFILLING, AND COMPACTING.

1.2 SUBMITTALS

- A. Comply with the requirements of Section 01 33 00 – SUBMITTAL PROCEDURES.
- B. Product Data: Manufacturer's literature and data, including, where applicable, pressure rating, capacity, labels, or other markings on equipment made to the specified standards for materials, for the following:
 - 1. Piping and fittings.
 - 2. Jointing material.
 - 3. Gaskets, couplings, and sleeves.
 - 4. Precast concrete structures, including manholes and drainage inlets.
 - 5. Concrete mix design for precast and cast-in-place structures.
 - 6. Manhole lids and frames.
 - 7. Manhole steps.
 - 8. Pipe to Structure Connection Seal.
 - 9. Drainage inlet grates and frames.

1.3 QUALITY ASSURANCE

- A. Comply with the latest editions of the following Standards and Regulations:
 - 1. American Society for Testing and Materials (ASTM).
 - a. A74: Cast Iron Soil Pipe and Fittings.
 - b. A615: Deformed and Plain Billet-Steel Bars for Reinforcement.
 - c. B32: Solder Metal.
 - d. C76: Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 - e. C150: Portland Cement.
 - f. C478: Precast Reinforced Concrete Manhole Sections.
 - g. C494: Chemical Admixtures for Concrete.
 - h. C920-02: Elastomeric Joint Sealants.
 - i. D2241-00: Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - j. D2680-01 Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
 - k. D2729: Perforated PVC Drain Pipe.
 - l. D3034-00: Type PSM Polyvinyl Chloride (PVC) Sewer pipe and Fittings.
 - m. F1336-02: Poly (Vinyl Chloride) (PVC) Gasketed Sewer Fittings.
 - 2. California Department of Transportation (Caltrans): Standard Specifications:
 - a. Section 51: Concrete Structures.
 - b. Section 52: Reinforcement.
 - c. Section 55: Steel Structures.
 - d. Section 66: Corrugated Metal Pipe.
 - e. Section 70: Miscellaneous Facilities.

- f. Section 72: Slope Protection.
- g. Section 75: Miscellaneous Metal.
- h. Section 90: Portland Cement Concrete.
3. County of Alameda Standard Plans and Specifications.
4. American Association of State Highway and Transportation Officials (AASHTO) for H20 Loading.
5. American Concrete Institute (ACI).
6. Other authorities having jurisdiction.

- B. System Description: Grades and elevations are to be established with reference to the benchmarks referenced on the Drawings.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage
1. Piping: Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.
 2. Metal Items: Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.
 3. Cement, Aggregate, and Reinforcement: As specified in Section 03 30 00 – Cast-In-Place Concrete.
- B. Handling
1. Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. When handling lined pipe, take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.

PART 2 - PRODUCTS

2.1 PIPING

- A. Polyvinyl Chloride (PVC) Pipe: PVC pipe conforming to ASTM D3034, SDR 26 with bell-and-spigot type of rubber gasket joints. Bells shall be integral with pipe. Spigot end pipe with separate double hub couplings is not acceptable.
- B. Reinforced Concrete Pipe (RCP): RCP shall conform to ASTM C76 with tongue-and-groove or bell-and-spigot joints. Unless indicated otherwise on the plans, all reinforced concrete pipe shall be Class III, 1350-D pipe.
- C. High-Density Polyethylene (HDPE) Pipe: HDPE Pipe shall conform to AASHTO M294 Type S. Acceptable for use in non-vehicular areas ONLY.
- D. Polyethylene Pipe (PE): PE 4710, Pressure Class 160, DR 13.5, conforming to AWWA C906. Driscoplex 4000/4100, or approved equivalent.
- E. Perforated Pipe: PVC conforming to ASTM D2729 or HDPE SDR 17 conforming to AWWA C906

2.2 MANHOLES

- A. Manholes shall be pre-cast concrete of the size and shape shown on the Drawings and shall conform to Sections 70-4.02 of the Caltrans Standard Specifications and to ASTM C478. Equivalent poured-in-place structures may be used at the Contractor's option. Concrete shall consist of Type II cement.

- B. Frames and covers shall be cast iron conforming to Section 75-2.02B of the Caltrans Standard Specifications. Manhole covers shall have the words "STORM DRAIN" in letters not less than 2-inches cast into the cover. The clear opening for all manhole covers shall be 24 inches.
- C. All interior concrete surfaces shall be coated with Xypex Concentrate or approved equivalent. Use of a water-resistant admix such as "Xypex Crystalline" is acceptable, at Contractor's option.
- D. Frames and grates for manholes and catch basins shall be match-marked in pairs before delivery to the job site. Grates shall be ductile iron conforming to Section 75-2.02B of the Caltrans Standard Specifications. The grates shall fit into their frames without rocking. Grates shall have a maximum opening of one-half inch between bars, unless otherwise noted in the Drawings. All drainage inlets shall be marked with a stencil or permanent label reading "NO DUMPING FLOWS TO CREEK."
- E. Reinforcing Bars: Reinforcing bars shall be of intermediate grade billet steel conforming to ASTM A615 and shall be of the size shown on the Standard Details or in the Drawings. Bars shall be of the round deformed type, free from injurious seams, flaws, or cracks, and shall be cleaned of all rust, dirt, grease and loose scales.
- F. Portland Cement Concrete: Concrete for manhole bases, inlets, and other concrete structures shall conform to the requirements of Caltrans Section 90 and as herein specified. The concrete shall be minor concrete. The grading of the combined aggregate shall conform with the Caltrans requirements of the 1/2-inch maximum. The consistency of the fresh aggregate shall be such that the slump does not exceed four inches, as determined by Test Method No. Calif. 520. The concrete shall have a minimum design compressive strength of 3,000 psi after 28 days.

2.3 PIPE TO STRUCTURE CONNECTOR/SEAL

- A. A flexible pipe to manhole connector shall be used for all pipe penetrations and/or cast-in-place concrete structures.
 - 1. The seal shall provide a flexible, positive, watertight connection between pipe and concrete wastewater structures. The connector shall assure that a seal is made between (1) the connector and the structure wall, and (2) between the connector and the pipe. The seal between the connector and the manhole wall shall be made by casting the connector integrally with the structure wall during the manufacturing process in such a manner that it will not pull out during coupling. The seal between connector and pipe will be made by way of a stainless steel take down band compressing the gasket against the outside diameter of the pipe.
 - 2. The connector shall be molded from materials whose physical/chemical properties meet or exceed the physical/chemical resistant properties outlined in ASTM C-923. The connector and stainless steel hardware shall meet or exceed the performance requirements proscribed in ASTM C-923.
 - 3. The connector shall be of size specifically designed for the pipe material being used and shall be installed in accordance with recommendations of the manufacturer.
 - 4. Connectors shall be Z-LOK or G3 connectors manufactured by A-LOK Products Inc. or approved equivalent.

2.4 CLEAN-OUTS

- A. A box shall be provided for each clean-out. Boxes shall be pre-cast concrete with cast iron frame and cover marked "STORM DRAIN"; Christy G05 or approved equivalent.

2.5 CULVERT AND OUTFALL HEADWALLS

- A. All headwalls shall be constructed in conformance with Caltrans Standard Plans as indicated.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. Pipe shall be installed in conformance with Section 31 23 33 – TRENCHING, BACKFILLING AND COMPACTING, and manufacturer's recommendations. HDPE pipe shall be installed in conformance with ASTM D2321 and as recommended by the pipe manufacturer. HDPE pipe is acceptable for use in non-vehicular areas ONLY.
- B. Pipe laying:
 - 1. No pipe shall be laid until the Geotechnical Engineer inspects and approves the conditions of the bottom of the trench.
 - 2. Pipe laying shall proceed "up grade" with the spigot section of the bell-and-spigot pipe pointing in the direction of the flow.
 - 3. Each section of pipe shall be laid true to line and grade and in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets in the flow line.
 - 4. Pipe shall not be laid when the condition of the trench or the weather is unsuitable.
- C. Debris Control:
 - 1. The interior of the sewer pipe shall be kept clean of dirt and debris at all times. When work is not in progress, open ends of pipe and fittings shall be plugged.
 - 2. Where clearing after laying is difficult because of small pipe size, a suitable swab or squeegee shall be kept in the pipe and pulled forward past every joint immediately after joining has been completed.

3.2 POURED-IN-PLACE CONCRETE

- A. Concrete shall be mixed in accordance with applicable provisions of Section 90 of the Caltrans Standard Specifications.
- B. Construction of concrete structures shall conform to applicable provisions of Section 51 of the Caltrans Standard Specifications. Unless otherwise noted herein or in the Drawings, exposed surfaces of structures shall be Class 1 surface finish.
- C. Curing shall conform to applicable portions in Section 90 of Caltrans Standard Specifications. No pigment shall be used in curing compounds. All work shall be subject to inspection. No concrete shall be placed until the District Representative has approved the forms and reinforcement.
- D. Concrete shall not be dropped freely where reinforcing bars will cause segregation, nor shall it be dropped freely more than six feet. Spouts, elephant trunks, or other approved means shall be used to prevent segregation.

3.3 PIPELINE FLUSHING

- A. Newly constructed storm drain pipes shall be flushed with water to clean. A metal screen shall be used to collect and remove any rock, silt and other debris that is flushed out during cleaning. Reclaimed water shall be used where available.

3.4 DEFLECTION TESTING

- A. Upon completion of work, perform a deflection test on entire length of installed plastic pipeline. Completed work includes superimposed loads adjacent to and over the pipeline, such as compacted backfill and earthwork, and does not include paving, concrete curbs and gutters, sidewalks, walkways, and landscaping.
- B. Under external loads, deflection of pipe in the installed pipeline shall not exceed 4.5 percent of the average inside diameter of pipe.
- C. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection-measuring device.
- D. Pull-Through Device:

1. Provide a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft.
 - a. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section.
 - b. Pull-through device may also be of a design approved by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device.
 2. Ball, cylinder, or circular sections shall conform to the following:
 - a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
 - b. A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.
 - c. Center bored and through bolted with a ¼ inch minimum diameter steel shaft having yield strength of not less than 70,000 pounds per square inch, with eyes or loops at each end for attaching pulling cables.
 - d. Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.
 3. Pull-Through Device:
 - a. Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water.
 - b. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.
- E. Deflection measuring Device:
1. Sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension.
 2. Obtain approval of deflection measuring device prior to use.
- F. Deflection Measuring Device Procedure:
1. Measure deflections through each run of installed pipe.
 2. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction.
 3. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflections, replace with new pipe, and completely retest in same manner and under same conditions.
- G. Warranty Period Test: Pipe found to have a deflection of greater than 5 percent of average inside diameter when deflection test is performed just prior to end of 1 year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection.

3.5 CLEANING

- A. Thoroughly clean storm drain lines, manholes, catch basins, field inlets, culverts, and similar structures, of dirt, debris, and obstructions of any kind.

3.6 VIDEO INSPECTION

- A. After completion of the pipe installation, service connections, flushing and cleaning, and prior to placement of pavement, the storm drainage line shall be televised with a color closed-circuit television with tilt-head camera recorded in DVD format. The original DVD and log sheets shall be provided to the District.
1. The following observations from television inspections will be considered defects in the construction of sewer pipelines and will require correction prior to placement of pavement:
 - a. Low spot (1 inch or greater - mainlines only).
 - b. Joint separations (3/4 inch or greater opening between pipe sections).
 - c. Cocked joints present in straight runs or on the wrong side of pipe curves.
 - d. Chips in pipe ends.
 - e. Cracked or damaged pipe.
 - f. Dropped joints.
 - g. Infiltration.

- h. Debris or other foreign objects.
- i. Other obvious deficiencies.
- j. Irregular condition without logical explanation.

END OF SECTION

SECTION 33 47 27 - BIORETENTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes:
 - 1. Bioretention Soil Mix (BSM)
 - 2. Aggregate Storage
 - 3. Mulch
 - 4. Streambed Gravel / Energy Dissipation Rock

- B. Related Sections:
 - 1. Section 31 20 00 – Earthwork and Grading
 - 2. Section 32 80 00 – Landscape Irrigation
 - 3. Section 32 90 00 – Planting

1.2 QUALITY ASSURANCE

- A. Comply with the latest editions of the following Standards and Regulations:
 - 1. Caltrans Standard Specifications
 - 2. American Society for Testing and Materials (ASTM), Philadelphia, PA, 1997 or latest edition
 - 3. NDPES Municipal Regional Permit: Attachment L
 - 4. Alameda County Clean Water Program C.3 Stormwater Technical Guidance document

1.3 DEFINITIONS

- A. Bioretention Soil Mix (BSM): A soil mix that has been specially blended and tested for use in bioretention facilities with the intent to meet the following objectives:
 - 1. Be sufficiently permeable to infiltrate runoff at a minimum rate of 5 inches per hour during the life of the facility, and
 - 2. Have sufficient moisture retention to support healthy vegetation.
 - 3. Consist of the following mixture of fine sand and compost, measured on a volume basis:
 - 4. 60%-70% Sand
 - 5. 30%-40% Compost

1.4 SUBMITTALS

- A. Pre-Installation Submittals: The Contractor shall submit to the Architect for approval:
 - 1. Bioretention Soil Submittals:
 - a. Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this specification.
 - b. Batch-specific test results and certification shall be required for projects installing more than 100 cubic yards of bioretention soil.
 - c. Grain size analysis results of the fine sand component performed in accordance with ASTM D422, Standard Test Method for Particle Size Analysis of Soils or Caltrans Test Method (CTM) C202.
 - d. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in PART 4 of this specification section .
 - e. Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
 - f. Grain size analysis results of compost component performed in accordance with ASTM D422, Standard Test Method for Particle Size Analysis of Soils.
 - g. A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.
 - 1) Provide the name of the testing laboratory(s) and the following information:
 - 2) Contact person(s)
 - 3) Address(s)

- 4) Phone contact(s)
 - 5) E-mail address(s)
 - 6) Qualifications of laboratory(s), and personnel including date of current certification by USCC STA, ASTM, Caltrans, or approved equivalent.
2. Other Submittals
- a. Cut sheets of any media or soil admixes to enhance moisture retention properties, if used.
 - b. Testing agency qualifications as specified in Section 1.06.B.
 - c. Streambed gravel / energy dissipation rock sieve analysis.

1.5 QUALITY CONTROL AND QUALITY ASSURANCE

- A. General: Test and inspect bioretention materials and operations as work progresses as described in this section. Failure to detect defective work or materials at any time will not prevent rejection if a defect is discovered after installation, nor shall it constitute final acceptance.
- B. Testing Agency Qualification:
1. General: Agencies that perform testing on bioretention materials, including permeability testing, shall be accredited by STA, ASTM, AASHTO, or other designated recognized standards organization. All certifications shall be current. Testing agency shall be capable of performing all tests to the designated and recognized standards specified and shall provide test results with an accompanying Manufacturer's Certificate of Compliance. Tests must be conducted within 120 days prior to the delivery date of the bioretention soil to the project site. The following information shall be provided for all testing laboratories used:
 - a. Name of lab(s) and contact person(s)
 - b. Address(es) and phone number(s)
 - c. Email address(es)
 - d. Qualifications of laboratory and personnel including the date of current certification by USCC STA, ASTM, Caltrans, or approved equivalent.
 2. Compost: Laboratory that performs testing shall be independent, enrolled in the US Composting Council's (USCC) Compost Analysis Proficiency (CAP) program, and perform testing in accordance with USCC Test Method for The Examination of Composting and Compost (TMECC). The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741, 631-737-4931, www.compostingcouncil.org.
- C. Responsibilities of Contractor
1. Pre-Placement Conference: A pre-placement conference will take place, including at a minimum the Landscape Architect, the Civil Engineer, the District's Representative, Installer, and general Contractor, to review schedule, products, soil testing, permeability testing, and installation. The Contractor shall notify the Civil Engineer a minimum of 5 working days prior to conference.
 2. Testing: All testing specified herein is the responsibility of the Contractor and shall be conducted by an independent testing agency, retained by the Contractor. The District's Representative reserves the right to conduct additional testing on all materials submitted, delivered, or in-place to ensure compliance with Specifications.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect the BSM and mulch from contamination and all sources of additional moisture at supplier site, during transport, and at the project site, until incorporated into the work.
- B. The Contractor is required to coordinate delivery of BSM and aggregates with bioretention facility construction and soil installation. A written schedule shall be submitted for review as part of the submittal package. BSM should not be stockpiled onsite for any length of time. In no case shall BSM be stockpiled onsite for more than 24 hours without prior written approval by the Civil Engineer. If stockpiling onsite for any length of time, BSM stockpiles shall meet the following requirements:
1. Locate stockpiles away from drainage courses, inlets, sewer cleanout vents, and concentrated stormwater flows
 2. Place stockpiles on geotextile fabric

3. Cover stockpiles with plastic or comparable material
4. Contain stockpiles (and prevent contamination from adjacent stockpiles) with temporary perimeter barrier (e.g., sand bags, wattles, silt fence).

PART 2 - PRODUCTS

2.1 BIORETENTION SOIL MIX (BSM):

A. Sand for Bioretention Soil:

1. Sand shall be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size shall be non-plastic.
2. Sand for Bioretention Soils shall be analyzed by an accredited lab using #200, #100, #40 or #50, #30, #16, #8, #4, and 3/8-inch sieves (ASTM C422, Caltrans CTM 202, or as approved by municipality), and meet the following gradation:

1.

Sieve Size	Percent Passing by Weight	
	Min	Max
3/8 inch	100	100
No. 4	90	100
No. 8	70	100
No. 16	40	95
No. 30	15	70
No. 40 or No. 50	5	55
No. 100	0	15
No. 200	0	5

Note: all sands complying with ASTM C33 for fine aggregate comply with the above gradation requirements.

B. Composted Material: Compost shall be well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes or other organic materials not including manure or biosolids meeting the standards developed by the US Composting Council (USCC). The product shall be certified through the USCC Seal of Testing Assurance (STA) Program (a compost testing and information disclosure program).

1. Compost Quality Analysis by Laboratory – Before delivery of the soil, the supplier shall submit a copy of lab analysis performed by a laboratory that is enrolled in the US Composting Council’s Compost Analysis Proficiency (CAP) program and using approved Test Methods for the Examination of Composting and Compost (TMECC). The lab report shall verify:
 - a. Organic Matter Content: 35% to 75% by dry weight.
 - b. Carbon and Nitrogen Ratio: C:N < 25:1 and C:N > 15:1.
 - c. Maturity/Stability: Any one of the following is required to indicate stability:
 - 1) Oxygen Test < 1.3 O₂ /unit TS /hr
 - 2) Specific Oxygen Test < 1.5 O₂ / unit BVS /hr
 - 3) Respiration test < 8 mg CO₂-C /g OM / day (or < 8 C / unit VS / day)
 - 4) Dewar test < 20°C temperature rise (maximum)
 - 5) Solvita® > 5 Index value
 - d. Toxicity: Any one of the following measures is sufficient to indicate non-toxicity:
 - 1) NH₄⁺: NO₃-N < 3
 - 2) Ammonium < 500 ppm, dry basis
 - 3) Seed Germination > 80% of control
 - 4) Plant Trials > 80% of control
 - 5) Solvita® > 5 Index value
 - e. Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.

- 1) Total Nitrogen content 0.9% or above.
- 2) Boron: Total shall be < 80 ppm; soluble shall be <2.5 ppm.
- f. Salinity: Must be reported; < 6.0 mmhos/cm
- g. pH shall be between 6.5 and 8. May vary with plant species.
2. Compost Quality Analysis by Compost Supplier – Before delivery of the compost to the soil supplier the Compost Supplier shall verify the following:
 - a. Feedstock materials shall be specified and include one or more of the following: landscaping/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
 - b. Maturity/Stability: shall have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell or containing recognizable grass or leaves, or is hot (120F) upon delivery or rewetting is not acceptable.
 - c. Weed seed/pathogen destruction: provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach min. 55C for 15 days with at least 5 turnings during that period.
3. Compost for Bioretention Soil Texture – Compost for bioretention soils shall be analyzed by an accredited lab using #200, 1/4 inch, 1/2 inch, and 1 inch sieves (ASTM D422 or as approved by municipality), and meet the following gradation:

Sieve Size	Percent Passing by Weight	
	Min	Max
1 inch	99	100
1/2 inch	90	100
1/4 inch ¹	40	99
No. 200	1	10

¹Max percent passing by Weight for the 1/4 inch sieve has been increased in response to locally available materials.
4. Bulk density shall be between 500 to 1,100 dry lbs/cubic yard.
5. Moisture content shall be between 30% - 55% of dry solids.
6. Inerts - compost shall be relatively free of inert ingredients, including glass, plastic and paper, < 1% by weight or volume.
7. Select Pathogens – Salmonella < 3 MPN/4 grams of TS, or Coliform Bacteria < 10,000 MPN/gram.
8. Trace Contaminants Metals (lead, mercury, etc.): Product must meet US EPA, 40 CFR 503 regulations.
9. Compost Testing – The compost supplier shall test all compost products within 120 calendar days prior to application. Samples shall be taken using the STA sample collection protocol. The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741, phone: 631-737-4931, www.compostingcouncil.org. The sample shall be sent to an independent STA Program-approved lab.

2.2 VERIFICATION OF ALTERNATIVE BIORETENTION SOIL MIXES

- A. Alternative soils for bioretention facilities shall be sufficiently permeable to infiltrate runoff at a minimum rate of 5 inches per hour during the life of the facility, and provide sufficient retention of moisture and nutrients to support healthy vegetation.
 1. General Requirements: Bioretention soil shall achieve a long-term, in-place infiltration rate of at least 5 inches per hour. Bioretention soil shall support vigorous plant growth.
 - a. Pre-installation Submittals: The applicant shall submit the soil mixture for approval.
 - 1) A minimum one-gallon size sample of mixed bioretention soil.
 - 2) Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this specification.
 - 3) Certification from an accredited geotechnical testing laboratory that the Bioretention Soil has an infiltration rate between 5 and 12 inches per hour as tested according to Section 2.02.1.b(ii)(2) below.
 - 4) Batch-specific test results and certification shall be required for projects installing more than 100 cubic yards of bioretention soil.
 - 5) Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, “Loss-On-Ignition Organic Matter Method”.

- 6) Grain size analysis results of mixed bioretention soil performed in accordance with ASTM D422, Standard Test Method for Particle Size Analysis of Soils.
- 7) A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.
- 8) Provide the name of the testing laboratory(s) and the following information:
 - a) Contact person(s)
 - b) Address(s)
 - c) Phone contact(s)
 - d) E-mail address(s)
 - e) Qualifications of laboratory(s), and personnel including date of current certification by USCC STA, ASTM, Caltrans, or approved equivalent.

B. Bioretention Soil Mix (BSM)

1. Bioretention Soil Texture: Bioretention soil mix shall be analyzed by an accredited lab using #200, and 1/2 inch sieves (ASTM D422 or as approved by the local municipality), and meet the following gradation:

2.

Sieve Size	Percent Passing (by Weight)	
	Min	Max
1/2 inch	97	100
No. 200	2	5

2. Bioretention Soil Permeability testing: Bioretention soil mix shall be analyzed by an accredited geotechnical laboratory for the following tests:
 - a. Moisture – density relationships (compaction tests) shall be conducted on bioretention soil. Bioretention soil for the permeability test shall be compacted to 85 to 90 percent of the maximum dry density (ASTM D1557).
 - b. Constant head permeability testing in accordance with ASTM D2434 shall be conducted on a minimum of two samples with a 6-inch mold and vacuum saturation.

2.3 AGGREGATE STORAGE

- A. Aggregate Storage shall be Class 2 permeable material per Caltrans Standard Specification Section 68-2.02F(3) and shall consist of hard, durable, and clean, sand, gravel, or mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove fines, organic matter, extraneous debris, or objectionable materials. On-site recycled materials are not permitted.

- B. Aggregate Storage shall meet the following specifications for grading and quality:

1. Aggregate gradation testing in accordance with ASTM C136 at least once per 500 cubic yards.

Sieve ¹	Percent Passing by Weight
	Caltrans Class 2 Permeable Aggregate ³
1 inch	100
3/4 inch	90 to 100
1/2 inch	–
3/8 inch	40 to 100
No. 4	25 to 40
No. 8	18 to 33
No. 16	–
No. 30	5 to 15
No. 50	0 to 7
No. 200 ²	0 to 3

¹Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

²Gradation modified from ASTM for portion passing the No. 200 sieve

³Per Caltrans Standard Specification Section 68-2.02F(3)

3. **Crushed Particles:** 90 percent (minimum) fractured faces tested in accordance with California Test 205. Do not use rounded river gravel.
4. **L.A Abrasion:** 40 percent (maximum) tested in accordance with ASTM C 131.

2.4 MULCH

A. General

1. Aged mulch, also called compost mulch, reduces the ability of weeds to establish, keeps soil moist and replenishes soil nutrients.
2. Mulch must not contain more than 0.1 percent of deleterious materials such as rocks, glass, plastics, metals, clods, weeds, weed seeds, coarse objects, sticks larger than the specified particle size, salts, paint, petroleum products, pesticides or other chemical residues harmful to plant or animal life.
3. Mulch shall be tree trimming mulch, or approved equivalent such as arbor mulch.

B. Tree Trimming Mulch

1. Tree trimming mulch must be derived from chipped trees and may contain leaves and small twigs. Materials shall conform to Caltrans Standard Specification Section 20-5.04B(5).
2. Tree trimming mulch must have a particle size such that a minimum of 95 percent of the material by volume is less than 3 inches and no more than 30 percent by volume is less than 1 inch.

2.5 STREAMBED GRAVEL / ENERGY DISSIPATION ROCK

A. General

1. Streambed Cobbles shall be clean, naturally occurring water rounded gravel material.
2. Streambed Cobbles shall have a well-graded distribution of cobble sizes and conform to the following gradation:

Streambed Cobbles

Approximate Size	Percent Passing by Weight
5 inch	100
4 inch	90–100
3 inch	25–40
2 inch	0–10

- a. Approximate size can be determined by taking the average dimension of the three axes of the rock, Length, Width, and Thickness, by use of the following calculation: $(\text{Length} + \text{Width} + \text{Thickness})/3 = \text{Approximate Size}$ Length is the longest axis, width is the second longest axis, and thickness is the shortest axis.
3. The grading of the cobbles shall be determined by the Contractor by visual inspection of the load before it is dumped into place, or, if so ordered by the Civil Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load.
4. Cobbles must be washed before placement

PART 3 - EXECUTION

3.1 GENERAL

- A. Prevent runoff from adjacent pervious and impervious surfaces from entering the bioretention facility (e.g., sand bag roof drains, flow diversion) until authorization is given by the Civil Engineer.

- B. Exclude equipment from bioretention facilities. No equipment shall operate within the facility once bioretention facility construction has begun, including during and after excavation, backfilling, mulching, or planting.
- C. Prevent foreign materials and substances, such as silt laden run-off, construction debris, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid from entering or being stored in the facility at any point during construction.
- D. The District's Representative may, at any time, conduct additional testing on all materials submitted, delivered, or in-place, to ensure compliance with the Specifications. Testing may include permeability testing per ASTM D2434 (Modified), density testing per ASTM D6938, etc., if the Engineer/Landscape Architect suspects the facility does not conform to these specifications (e.g., as evidenced by lower than anticipated infiltration capacity).
- E. Contractor to provide Civil Engineer written records documenting dates; company name of participants; descriptions; locations; and results of tests and/or measurements undertaken as described in PART 3 of this specification. Contractor to provide written records to Civil Engineer no more than 2 work days after completion of test and/or measurement (e.g. "01 January 2018, Cherry Tree Landscapes, soil density measured, FTP 01, 81 percent compaction").

3.2 GRADING

- A. The Contractor shall not start bioretention facility grading until all areas draining to the facility are stabilized and authorization has been given by the Civil Engineer.
- B. Construct bioretention facility subgrade to +/- 3/4 inch of the grades and slopes specified on the construction documents.
- C. Excavation within 6 inches of final native soil grade shall not be permitted if facility soils have standing water, or have been subjected to more than 1/2 inch of precipitation within the previous 48 hours.

3.3 SUBGRADE PREPARATION AND PROTECTION

- A. Protect the bioretention excavation from over compaction and/or contamination.
 - 1. Areas which have been over compacted by equipment or vehicle traffic or by other means and which need to be ripped, over excavated receive additional scarification, or other restorative means shall be done at the Contractor's expense and at the direction of the Civil Engineer.
 - 2. Excavated areas contaminated by sediment-laden runoff prior to placement of BSM or aggregate storage material shall be remediated at the Contractor's expense by removing the contaminated soil (top 3 inches minimum) and replacing with a suitable material, as determined by the Civil Engineer.
- B. Remove all trash, debris, construction waste, cement dust and/or slurry, or any other materials that may impede infiltration into prepare subgrade.
- C. The subgrade shall be inspected and accepted by the Civil Engineer prior to placement of any materials or final subgrade scarification.
- D. Scarify the surface of the subgrade to a minimum depth of 3 inches immediately prior to placement of BSM or aggregate storage material. Acceptable methods of scarification include use of excavator bucket teeth or a rototiller to loosen the surface of the subgrade.
- E. Place aggregate storage material where shown on drawings with conveyor belt or with an excavator or loader from a height no higher than 6 feet unless otherwise approved by the Engineer. Do not dump material directly from truck into the cell.

- F. Aggregate storage areas contaminated by sediment-laden runoff prior to placement of BSM shall be remediated at the Contractor's expense by removing the contaminated aggregate storage material (top 3 inches minimum or as directed by the Civil Engineer and replacing with clean aggregate storage material per Section 2.03, to the lines and grades on the contract documents.
- G. Aggregate storage material shall be inspected and accepted for placement and finish grade by the Engineer prior to the installation of BSM. Any material that does not conform to this specification shall be removed and replaced with acceptable material or remediated to the satisfaction of the Civil Engineer, at the Contractors' expense.

3.4 BIORETENTION SOIL MIX (BSM) PLACEMENT

- A. The Contractor shall not place BSM until the [District's/Owner's Representative] has reviewed and confirmed the following:
 - 1. BSM delivery ticket(s): Delivery tickets shall show that the full delivered amount of BSM matches the product type, volume and manufacturer named in the submittals. Each delivered batch of BSM shall be accompanied by a certification letter from the supplier verifying that the material meets specifications and is supplied from the approved BSM stockpile.
 - 2. Visual match with submitted samples: Delivered product will be compared to the submitted 1-gallon sample, to verify that it matches the submitted sample. The Civil Engineer may inspect any loads of BSM on delivery and stop placement if the soil does not appear to match the submittals; and require sampling and testing of the delivered soil to determine if the soil meets the requirements of Section 2.01 of this specification before authorizing soil placement.
 - 3. Inspection of the aggregate storage layer, underdrain, cleanout, and overflow structure installation by the Civil Engineer or third-party peer reviewer, to confirm it is built per plan.
- B. BSM placement, grading and consolidation shall not occur when the BSM is excessively wet, or has been subjected to more than 1/2 inch of precipitation within 48 hours prior to placement. Excessively wet is defined as being at or above 22 percent soil moisture by a General Tools & Instruments DSMM500 Precision Digital Soil Moisture Meter with Probe (or equivalent). A minimum of three readings with the soil moisture probe will be used to determine the average percent soil moisture reading per each truck load. There should be no visible free water in the material.
- C. The Contractor shall place BSM loosely with a conveyor belt or other means from a height no higher than 6 feet, unless otherwise approved by the Civil Engineer. Soil shall be placed in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Civil Engineer.
- D. Excessively dry BSM may be lightly and uniformly moistened, as necessary, to facilitate placement and workability.
- E. Compact BSM using non-mechanical compaction methods (e.g., boot packing, hand tamping, or water consolidation) to 83 percent (+/- 2 percent) of the maximum dry density per modified Proctor test (ASTM D1557), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6938. Moisture content determination shall be conducted on a soil sample taken at the location of the nuclear gage reading per ASTM D2216.
- F. Grade BSM to a smooth, uniform surface plane with loose, uniformly fine texture. Rake, remove ridges, and fill depressions to meet finish grades.
- G. Final soil depth shall be measured and verified only after the soil has been compacted. If after consolidation, the soil is not within +/- 3/4 inch of the grades and slopes specified on the Plans, add material to bring it up to final grade and rake.
- H. The BSM shall be inspected and accepted for placement and finish grade by the Civil Engineer prior to the installation of planting and mulch. Any BSM that does not conform to this Specification shall be remediated to the satisfaction of the Civil Engineer, or removed and replaced with acceptable BSM, at the Contractor's expense.

3.5 PLANTING AND MULCHING

- A. Bioretention facilities shall be planted and mulched as shown on the contract documents.
- B. Bioretention facilities shall not be planted or mulched when soils are excessively wet as defined in Section 3.04 of this specification.
- C. Bioretention facility areas contaminated by sediment laden runoff prior to planting or placement of mulch shall be remediated at the Contractor's expense by removing the contaminated BSM (top 3 inches minimum) and replacing with BSM per Section 2.01 of this specification, to the lines and grades on the contract documents.
- D. All mulch shall be inspected and accepted by the Landscape Architect to ensure appropriate depth and material prior to facility commissioning (e.g., unblocking of inlets).

3.6 FLOOD TESTING

- A. Inlets shall be constructed per the contract documents and free from all obstructions prior to commencing flow testing.
- B. Testing shall be conducted at the conclusion of the 90-day plant grow-in period. Protection and flow diversion measures shall be removed in their entirety prior to commencing flow testing.
- C. Underdrains shall be plugged at the outlet structure to minimize water consumption during testing.
- D. Prior to testing, broom sweep gutter and other impervious surfaces within the test area to remove sediments and other objectionable materials.
- E. The Civil Engineer shall be present during the demonstration. The Contractor shall notify the Civil Engineer a minimum of 5 working days prior to testing.
- F. The Contractor shall water test each facility to demonstrate that all inlet curb openings are capturing and diverting all water in the gutter to the facility, outlet structures are engaging at the elevation specified, and the designed ponding depth is achieved. Testing shall include application of water from a hydrant or water truck, at a minimum rate of 10 gallons per minute, into the gutter a minimum of 15 feet upstream of the inlet curb opening being tested. Each inlet shall be tested individually. If erosion occurs during testing, restore soils, plants, and other affected materials.
- G. Landscape Architect and/or Civil Engineer will identify deficiencies and required corrections, including but not limited to relocating misplaced plants, adjusting streambed gravel, adjusting mulch, adjusting inlets, splash aprons, and forebays, removing and replacing inlets, and removing debris.
- H. Once adjustments are made, the Contractor shall re-test to confirm all test water flows into the facility from the roof drains and correct any remaining deficiencies identified by Civil Engineer.
- I. Inlets, outlets, and other bioretention facility appurtenances shall not be accepted until testing and any required correction and retesting is complete and accepted by the Civil Engineer.

END OF SECTION